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HAND-BOOK

OF

DENTAL ANATOMY AND SURGERY.

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OF

ENTAL ANATOMY AND SURGERY

FOR THE USE OF

STUDENTS AND PRACTITIONERS

BY

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SURGEON DENTIST TO THE QUEEN,

SURGEON DENTIST TO THE ROYAL INFIRMARY, ROYAL HOSPITAL FOR SICK CHILDREN, ETC., EDINBURGH.

SECOND EDITION.

LONDON:

J. & A. CHURCHILL, NEW BURLINGTON STREET.

1871.

PRINTED BY NEILL AND COMPANY, EDINBURGH.

WU
101
S652p
1871

PREFACE.

THE object of the present work being to afford a condensed view of what is known at the present day of dental structure and diseases, it is in this manner intended to serve either as a Text-book for those who desire to pursue a special and further acquaintance with these subjects; or as a Hand-book for such as may find the memoranda it contains occasionally serviceable in general practice. In issuing the second edition, the original arrangement of the book has been adhered to; but considerable alterations and additions in some parts have been necessitated by the recent advances made in all departments of medicine and surgery since its first publication. For those who

might wish more extended information on the matters treated of, a list of authorities is given, with numbers referring to them, marked throughout the volume; and a short chapter on the principles involved in the mechanism and use of artificial teeth is added to the former contents, as rendering any treatise on Dental Surgery somewhat more complete.

EDINBURGH, 11 WEMYSS PLACE,
April 1871.

PREFACE TO THE FIRST EDITION.

During the Summer Session of 1856, it was proposed that I should deliver at the Medical School, Surgeons' Hall, a short course of lectures on Dental Surgery. Throughout that and subsequent sessions, I felt the want of a concise work on the subjects brought under notice. Several excellent and comprehensive treatises on the Anatomy and Diseases of the Teeth no doubt existed; but they were not of a character suiting the requirements of the class. Along with advanced medical students, a considerable number of the pupils were the ordinary assistants of dental practitioners, and unacquainted with many of the mere elementary facts in medicine. The idea thus occurred to me of

drawing up a volume of small size, and of such a nature as would render it acceptable to medical students, while it would afford to non-medical pupils an epitome of those leading facts in anatomy and physiology, essential for entering on the study of dental disease.

The conviction that an exclusively special knowledge of any one department of medicine or surgery was objectionable, almost led me to treat the subject in a manner pre-supposing some advance to have been made in the usual branches of a medical education. This, however, would have frustrated the end I had in view. I have therefore attempted nothing more than an exposition, in a condensed form, and simple terms, of the anatomy and pathology of the teeth in relation to ordinary dental practice.

In a work of the kind there can be little claim to originality, beyond the selection and arrangement of proper materials, and their reduction to the smallest space consistent with perspicuity.

In doing so, I have availed myself of the advantages afforded in the works of various well-known authorities, and made whatever selections seemed suitable for the purpose from some of my own published papers.

The small size of the volume necessarily renders the treatment of many subjects terse. But it will be found that very few, if any, of practical interest have not been touched upon; while those of more general utility have been discussed at considerable length.

EDINBURGH, 11 WEMYSS PLACE,
November 1864.

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DENTAL ANATOMY AND SURGERY.

CHAPTER I.

INTRODUCTORY.

THE PRINCIPAL FORMS OF TEETH IN THE LOWER ANIMALS.

Much importance has always been attached to Anatomy and Physiology as a means of elucidating not only the nature but the diseases of a part. In general, however, the anatomy merely of the part itself cannot be deemed sufficient for such purposes: its dependence on, or its associations with, others cannot be set aside. Because in many cases the diseased no less than the healthy condition of one, depends upon the functional condition of some other organ, so remote, perhaps, as never to be suspected, without a previous acquaintance with the connection subsisting between them. Proceeding upon the same principle, and going a step further, it

is of much advantage in many ways, that, besides the Human anatomy of any organ or set of organs, we should be aware of those peculiarities which may attach to the Comparative anatomy of similar parts. Many things become far more comprehensible in human anatomy when we refer to the same structure—existing, perhaps, in a higher state of development—in some of the lower animals; as, for example, in the case of the canine teeth in man, where we find them but feeble representatives of those organs in their more perfect state among the carnivora.

In this manner a knowledge of anatomy and physiology, in their fullest sense, and in their combined application to pathology, or the laws of disease, becomes the basis of all scientific medicine. Every irregularity, every defect in form, every morbid symptom, may be judged of on such a basis. Whether the nature of a mere localised disorder be inquired into, or the cause of disease in one part be sought for as associated with some altered function in another, physiology affords the key to its interpretation, anatomy, the standard by which to estimate the organic change incurred (34).

What has here, however, more particularly to be considered, is of local limits, and must be restricted to the anatomy and pathology of the dental system alone. The method followed must therefore partake to a considerable extent of what is termed the *déduction anatomique* of the French physiologists, namely, the examination of the component textures and external forms of one system of organs specially, and, by inference, the deduction of their functions and their conditions in health and disease.

COMPARATIVE ANATOMY.

In entering upon the study of dental disease, it is, then, expedient that a correct general knowledge should be possessed regarding the various forms assumed by teeth. This subject presents a twofold aspect, as has been already adverted to—naturally dividing itself into two separate although associated branches—the one as applied more particularly to the pathology of these organs in man ; the other relating to the teeth of the lower animals, and extending its application more particularly to the department of natural science. Before proceeding, then, to describe the dental system of man, a few of the

principal forms of teeth in the lower animals may be briefly mentioned.

The teeth of the human subject afford but a very limited and imperfect idea of these organs throughout the animal kingdom. Among the lower animals, the number, the form, the situation, and the uses of teeth, vary to a very great degree. In Number we have them varying from the countless teeth of some fishes, to the solitary tooth of the monodon or narwhal—the tooth so well known for its resemblance to the unicorn's horn of heraldic notoriety. In Position, we have them not confined to the jaws, as in man, but, as in fishes and reptiles, scattered over all the bones of the mouth, the tongue, the gullet, and, if we include some still lower animals, such as crabs, beetles, and various insects, we find teeth, or organs corresponding to them, situated even in the stomach. In Form, again, we have them infinitely diversified. From simple flat plates, as in some of the ray and skate group of fishes, we have them modified, till we find them assuming the form of the elephant's tusk, or the whalebone of the cetacean family, producing that peculiar substance. In their Uses we find them serving the purposes of attack in the lion;

of building in the beaver; of climbing and progression in the walrus; of digging in the extinct dinotherium; of prehension in fishes; of poisoning in serpents; and of speech and appearance in man (9).

Nothing like a common pattern or type of teeth, either in form or position, prevails among animals lower in the scale of being than the fishes. It is only when we rise to them,—belonging as they do to the vertebrate or backboned animals,—that these organs can properly be recognised as a system.

In some of the rotiferæ or wheel animalcules, we have a teeth-like apparatus in the stomach. Among these minute animals the *Brachionus urceolaris* presents an apparatus of this kind, consisting of two little hammer-like teeth, working upon another tooth or dental body, the whole acting like two hammers striking on one anvil, and in this way reducing the food to a proper consistence for subsequent digestion.

In the echinus or sea urchin, again, an animal well known on our sea coasts, a somewhat complex form of jaws and teeth exists. Five bent and pointed teeth project from that part of the shell forming the mouth; each of these five

teeth is contained in a separate jaw, which is movable; and their mode of use is peculiar, inasmuch as, while the food is seized by the teeth, it is ground down by the adjacent sides of the jaws themselves rubbing against each other.

Many insects have a system of horny teeth situated in the stomach or gizzard.

The common crab has not only a dental apparatus external to the body, but is provided with a powerful form of teeth within the stomach.

The ordinary limpet of our shores has its long tongue thickly bristling with regularly arranged teeth in immense numbers.

The peculiar wound inflicted by the leech is familiar to every one. Its triangular bite is produced by the action of three little semicircular saws, which constitute its dental apparatus.

Even the common snail has a peculiarly constructed set of teeth, resembling a small comb; and with this it can rapidly cut down the vegetable matter among which it feeds.

No more, however, need be said of the diversified forms of teeth met with in animals lower than the fishes. Passing on to them, therefore, we leave the invertebrate and enter the verte-

brate division of animals. All vertebrate animals, with a few tolerably well known exceptions, possess teeth. Among those destitute of such organs may be mentioned the whole class of birds; a few of the amphibia and fishes; the chelonian reptiles; and among mammals, the monotremeta, and most of the ant-eaters (5). The teeth of the vertebrata—fishes, reptiles, and mammals—are all, more or less, of the same characters; they are all modifications of a cone in their form, and they are always situated in, and in the neighbourhood of, the mouth. In such respects, however, they present considerable variety among themselves.

The simplest forms of these teeth are such as are met with in some fishes. In the skate and several allied individuals, the teeth consist of flat plates of bone, covering the interior of the mouth like a pavement. The first approach towards a conical or pointed form of tooth may frequently be found occurring in such a pavement, by some of its flat plates becoming prominent at the centre, and indicating a tendency to assume the projecting or cone-shaped form described. Passing to other fishes, we find cone-shaped teeth to have become the general rule,

until they present the high degree of development seen in such examples as the pike, the sea-wolf, and some sharks—the pike with its array of strong, recurved, pointed blades, calculated for retaining its slippery prey; the sea-wolf with its prehensile and powerful grappling teeth, situated in the front of its mouth, and its no less powerful crushing ones behind; and the sharks, with their remarkable dental system, composed of tier upon tier, all round the jaws, of flat triangular teeth, compressed cones, in fact, an arrangement perfectly adapted to the savage nature and voracious habits of these creatures.

The next class of animals higher than the fishes is that of the reptiles, and among them we find some remarkable forms of teeth, constituting still, however, only further developments of the cone. This class of animals is more properly divided into two, namely, Batrachia and Reptilia; here, however, both are included under the name of reptiles.

Some of these animals, such as turtles and tortoises, have no teeth, but merely a horny covering extended over the jaws; others, like frogs, have only upper teeth; while others, again,

such as some serpents, have teeth not only in both jaws, but also situated upon the palate. Among the various examples of reptilian teeth, crocodiles and serpents present some points of greater interest in their dental apparatus. The number of teeth in the crocodile seems to remain the same throughout the long life of this animal, but they individually increase in size as the animal grows, and go on being shed and renewed as long as it lives. In the poisonous serpents, again, there is found a characteristic form of tooth, viz., the poison fang, sometimes erroneously spoken of as the sting. This weapon consists of a long, curved, and pointed tooth, situated on each side near the fore part of the mouth. This tooth is hollow or tubular throughout its length, the tube commencing at its root and ending near but not quite at its point, in a small hole opening on the surface of the tooth. The object of this construction is, that on the animal using this tooth, the poison contained in the poison-bag connected with its root is injected along the tooth into the wound thus made. These teeth, except when the creature is irritated and about to use them, lie flat upon the surface of the mouth, being provided with a

hinge-like articulating apparatus for this purpose.

Among extinct reptiles many interesting forms of teeth exist, and, according to their dental peculiarities, several of these animals have been named. The Dicynodon appears to have been a kind of tortoise, with two large and ever-growing tusks situated in its upper jaw, and curving downwards and forwards. The Labyrinthodon, as its name implies, was provided with pointed teeth of a very complex structure, their tissues being arranged in a number of inflections inwards from the surface. This animal was a gigantic lizard-like toad, but not of such enormous proportions as the Iguanodon, another elephantoid reptile, named from its teeth presenting a character similar to those of the iguana, their shape being of a peculiar palmate or leaf-like form, with sharp serrated edges, adapted for cutting down the vegetable matters upon which the iguanodon subsisted. And among animal-feeders we find the Megalosaurus, another stupendous lizard, some thirty feet long, and furnished with an apparatus of teeth in the form of long, curved, double-edged blades, not only cutting at these edges, but having them provided

with serrations, which enabled these formidable creatures literally to saw through the tough hides of their usual victims.

In the mammalia the teeth are confined to the upper and lower jaw, and in most instances are renewed once during a lifetime. In some animals no renewal or second series of teeth is provided; so that in their case the teeth are never shed and succeeded by others, as occurs where a temporary and a permanent set exist; but on any tooth being lost by them, it is never replaced. The dolphins, the armadillos, and the sloths, are examples of this form of dentition.

Another peculiarity exhibited by some teeth among the mammalia is that of continuous and uninterrupted growth. This is seen in the incisors of rodent animals, in the molars of the sloth, in the tusks of elephants, and some other similar kinds of teeth. The object of such a mode of development is, that as the tooth is being worn down at its point, it continues constantly growing at its base, thus maintaining its normal bulk and usefulness; and so persistent and certain is the occurrence of this growth, that in cases where the usual abrasion of the extremity of the tooth becomes arrested, it goes on in-

creasing in length until it constitutes not only an inconvenience, but sometimes a cause of death, in the animal to which it belongs, by impeding the motion of the jaws, and thus leading to starvation.

The teeth in the mammalia may, in a general manner, be classified into those of the carnivora, those of the herbivora, and those partaking more or less of the characters of both, as in the omnivorous animals, such as man.

Of the carnivorous order, the lion may be selected as illustrating all those characters of a dental system perfectly adapted for a terrestrial flesh-feeding animal. The jaws are here found massive and short, so that the teeth are situated as near the articulation as possible—that part, in such a form of lever as the jaw, where the power is greatest. And we find the teeth themselves equally well suited for their work. We find the canines long, powerful, and securely implanted in the jaw, in every way adapted for deeply wounding and retaining a living and struggling victim. The molar teeth, again, instead of presenting a broad, tuberculated, crushing surface, as in man, present something like a wavy knife edge, and closing over one another when

the upper and lower jaws meet, they divide the substances submitted to their action, as the blades of a pair of scissors are found to do. They are, in short, sectorial instead of grinding teeth. The incisors, again, are short, nibbling organs, intended, and well adapted, for gnawing the fragments of soft tissues left adhering to the bones after the more arduous duties have been fulfilled by the canines and molars.

The ruminant animals, such as the ox, may be taken as affording a well-marked example of the herbivorous form of dental system. In these animals we find the canines absent, or but in a rudimentary condition; we find the incisors frequently deficient in number, and adapted for the browsing propensities of the owner; while the molars are provided with sharp ridges of enamel interspersed throughout their substance, so that the free or grinding surface of the tooth presents an alternation of hollows and sharp ridges, well calculated for bruising and reducing to a pulp the vegetable matters serving these animals as food, but which would be utterly ineffective for the purposes of such creatures as the lion. The jaw, too, in the herbivorous animal is long and slender, and at its

extremity, where the canines are occasionally slightly represented, its action is comparatively feeble and unsteady.

Among the mammalia another form of teeth is worthy of notice here, namely, those belonging to that form of whale producing "whalebone," and which constitute that particular substance. Along the sides of the palate in these animals the upper teeth are arranged in the form of horny plates depending downwards into the mouth, their lower extremity terminating in a sort of hair-like fringe. These teeth constitute the whalebone of commerce, and the use of such a construction of teeth is that, on the whale admitting within its widely-opened jaws a shoal of the small animals serving it for food, its mouth is again closed, and the water being strained off through the horny fringes of the baleen plates, its prey is thus retained and swallowed.

When speaking of the teeth of reptiles, several of the extinct forms of these animals were alluded to. Among the mammalia there are also found several interesting forms of teeth belonging to animals now extinct. The Dinotherium, the Mastodon, and the Mammoth, may be men-

tioned as illustrative examples. These were all enormous animals possessed of tusks resembling those of the existing elephants. The dinotherium had a pair of such tusks curving downwards from its lower jaw. The mastodon, in addition to a pair of tusks in the upper jaw, as elephants have, had also a pair situated in the lower jaw. And the mammoth was provided with a pair of tusks in the upper jaw, some of which have been found nearly 12 feet long, and weighing 200 lbs. Besides such tusks, these animals were provided with molars of proportionate magnitude, some specimens of those in the mastodon weighing from 17 lbs. to 20 lbs. each.

Such are a few examples of teeth as they occur in the lower animals, some circumstances connected with which subject will be found to bear upon certain apparent anomalies in the pathology of the human teeth.

CHAPTER II.

GENERAL CHARACTERS OF THE TEETH IN MAN.

Anatomists consider 44 instead of 32 to be the typical or model number of teeth belonging to those animals comprising the mammalia, and therefore they consider that certain teeth in man, and in several other animals, are suppressed; 44 ought, as it were, to be present, but 12 of those in man are suppressed, reducing the number to 32 (9). A knowledge of this diminution in the typical number of teeth in man is so far interesting, as it affords one explanation of the occurrence of what is sometimes believed to be a third dentition,—the growth of a third series of teeth; as well as the occasional existence of extra teeth in the mouth. Such supernumerary members, in both cases, frequently indicate merely the tendency towards a return to the original or typical number, which had been in the first instance departed from.

These 32 teeth are arranged and classified in the same way, in both the upper and lower jaw, —16 in each. In front, above and below, are 4 cutting teeth, flat at their edges, and termed Incisors. Bounding these, on each side, is a conical spear-shaped tooth, termed the Canine or eye-tooth. Behind the canine we have 2 small tuberculated teeth, termed Bicuspids, or small grinders,—2 on each side, above and below. Behind these again we have 3 large grinders, or the true Molar teeth—3 on each side, above and below. These 3 true molar teeth only appear once in a lifetime, and only with the permanent teeth. They are not represented at all in the temporary set, or milk-teeth of the child; so that the first or milk-set differs from the second or permanent set, in being 12 teeth fewer—6 above, and 6 below. The milk-set thus being only 20 in number, instead of 32, and the difference consisting in the absence of any direct predecessors to the true molar teeth.

Man differs from all other animals in the arrangement of his teeth. In him, they are all of one length, all on the same level at the crowns. Again, no interspaces exist among them, every tooth being close to the one next it; whereas,

among the lower animals, empty spaces exist at certain parts along the jaw, the series of teeth being interrupted by gaps or vacancies, generally occurring near the canine teeth; and, in such animals, these canine or eye-teeth themselves are almost always much longer than any of their neighbours, and thus over-top them considerably. The existence of these unoccupied spaces, these gaps among the teeth of the lower animals, may very well account for their not suffering, as man does, from irregularity or crowding of the teeth; and probably the extra room thus afforded may explain also why animals suffer so much less during dentition or teething than is the case in man, where the jaw is barely, if it is actually sufficient, to contain the teeth with which it is normally furnished (20).

Again, in reference to these more external characters of teeth, each is coated or capped, on its exposed portion or crown, with a dense hard covering of what is termed enamel; and, on its root or fang, or that part imbedded in the jaw, it is coated with another and softer substance, termed cement. In this way each tooth is composed of three different substances, to be presently described, viz.:—1*st*, a body or base, com-

posed of dentine; 2*d*, a cap, investing the crown, and termed enamel; 3*d*, a substance coating that, and termed cement. The centre of the tooth, and of each fang, encloses a soft substance termed the pulp, and containing blood-vessels and nerves.

Lastly, so far as external form is concerned, the character of root or fang, exhibited by each tooth, is one of the chief marks by which these organs are distinguished from each other. The natural form of root, as is more fully described in another chapter—viz., that on the anatomy of these parts—is in general terms in all the incisor teeth, above and below, a single, straight, conical fang. In the canine teeth the same form is observed. In the bicuspids of the lower jaw, the same style of root continues, but in those of the upper jaw the root inclines to be double,—to divide into two fangs. In all the upper molars, the number of fangs is three; two outside, and one towards the palate. In all the lower molars the natural number of the fangs is two, one behind the other.

A knowledge of the character of root and fang possessed by each tooth is one of the chief guides we possess for distinguishing these organs

from each other; and a knowledge of the number, form, and direction of these fangs is essential for the skilful performance of tooth extraction,—as by such acquaintance a tooth is extracted with much more rapidity, and greater ease both to operator and patient, than by a blind attempt at removal without attention to its form and mode of fixation.

Besides a familiarity with the form of these organs, a knowledge of their intimate structure and mode of development is necessary for correctly understanding their diseases.

And here it may be premised, that any remarks on the structure, development, or morbid changes observable in the parts of animal bodies, will be better understood by previously knowing something of their microscopic constituents. Animal tissues are made up of exceedingly minute organic particles, fibres, and membranes,—all of them quite invisible to the unassisted eye, and constituting what have been variously named and described as granules, molecules, fibres, cells, &c. The last mentioned—namely, the cell—has always been regarded as the most important of these different structures. Among the earlier physiologists,

cells were regarded as minute vesicles having a wall enclosing a cavity in which were fluid contents and a nucleus. Later researches, however, have shown that what were originally termed cells have in many cases no title to be so denominated, as what is now known of such bodies shows them to be often merely little masses of what is termed protoplasm with or without a nucleus (37). This protoplasm is a substance possessing the peculiar vital properties essential to living bodies—namely, the power of spontaneous movement, nutrition, growth, and reproduction of its own kind. Both the nucleus and protoplasm are generally products of the division of similar constituents of another cell. The protoplasm itself is structureless, but may contain various substances, and in this way the cell becomes differentiated from others. Thus when containing oil granules, it becomes a fat cell —pigment, a pigment cell—calcareous salts, a bone cell, &c. Much diversity exists in the functions performed by cells, and their multiplicity of form is no less remarkable. The origin, development, nutrition, functions, and death of cells, would occupy much greater space, however, than can possibly be here devoted to these

subjects. And it is sufficient to know that in any casual mention of them, such as may be required in these pages, reference is made to the almost infinitesimally minute bodies just described.

At an extremely early period of life—at the mere dawn of existence, indeed—there is formed in the mucous membrane of the mouth, occupying the situation of the future teeth, a groove or trench, extending in a horse-shoe shaped, or rather crescentic form, round the margin of the jaws. This trench is termed the dental groove, and here occur all those processes which constitute dentition or teething; in other words, the growth and development of the teeth (2).

The process commences by the dental groove deepening and dipping down into the substance of the mucous membrane of the jaw. This sunken portion is further covered in by the mucous membrane itself growing up on each side, and the cavity thus formed becomes what has been denominated the enamel germ (6). Coincident with this process another structure has been developed below the enamel germ,—viz., the dentinal germ. This structure appears under and projects into the enamel germ,

lifting it so as to be covered by it like a cap. From this time the enamel germ begins to take on an action by which it is divided into portions, one of which is allotted to each of the future individual teeth—and each of these portions is now termed the enamel organ,—this and the dentinal germ constituting the rudiments of a tooth, and ultimately becoming the enamel and tooth-bone respectively. Septa or partitions begin to be developed across the rudimentary jaw, thus providing each rudimentary tooth, including both the enamel and dentinal elements, with a separate apartment—as yet, however, so to speak, roofless. In this condition the young tooth is termed a papilla, and its containing cavity a follicle. But matters speedily become changed; the papilla rapidly increases in size, and the containing cavity becomes roofed in, the papilla now commonly assuming the designation of the pulp, and the enclosing cavity the name of the sac. This sac is so wide that a space exists between it and its enclosed pulp; but the space thus present is not empty, but is occupied by certain formative structures, and what appears as a thick transparent fluid, so that three different elements

thus enter into the germinal or embryonic condition of the tooth, viz., the Pulp, the Thick fluid surrounding it, and the Sac enclosing both,—the sac and its contents being again lodged in the substance of the jaw.

And now commence those changes by which these as yet soft tissues are converted into the future tooth. The pulp takes on an action by which its soft substance is transformed into the hard material forming the body of the tooth—the material mentioned as being denominated Dentine. The thick fluid and other elements interposed between the pulp and the sac is replaced by the cap of Enamel, described as covering the crown or exposed portion of the tooth; and at a later stage, because the root or fang does not grow until the crown is completed, the sac itself enters into the formation of the substance referred to as coating the root of the tooth, and termed the Cement.

As soon as the crown of the tooth is completed, and long before the root is perfect, the process takes place by which the tooth is "cut," as it is called. This takes place, not by the tooth forcing or tearing a way or passage for itself through the gums and other tissues, but

by these tissues themselves making a way for the tooth's escape. An opening is, if we may so speak, *spontaneously* formed in the top of the sac; the tooth protrudes through this opening, and the sides of the sac contracting to a certain extent, the tooth is hoisted by them a little way out of the gum. This lifting up of the young tooth, on its first penetrating the gum, makes it appear to grow more rapidly than it really does. Such apparent rapidity of growth during the first few hours of a tooth's existence in the mouth being, however, deceptive, and arising from the fact just specified (7).

This constitutes the explanation—the *rationale* of that strictly natural and healthy process going on in infant life, and termed "teething;" not a step in which is detrimental or to be regarded as disease. Dentition may, like every other natural process, assume a diseased or morbid condition, but in no ordinary case does it deserve the bad character generally assigned it (20).

The first or temporary set, however, is soon lost and replaced by others which are to be renewed no more—the permanent or adult teeth. The various steps by which this second dentition is effected might here be described; but with

some obvious and slight modifications, they so closely resemble those exhibited in the first dentition, that it might be tedious to do more than merely mention this occurrence. What is chiefly to be borne in mind respecting this renewal of the teeth is, that in man and all the higher animals, it occurs in a whole lifetime only once. The general features of the process are the same as those of the first dentition; the follicular and saccular stages occur as in it; enamel, dentine, and cement are formed as in it, the main differences being that the majority of the teeth in the second or permanent set have had predecessors among those of the first set they form, as it were, a second crop, and this second crop is much longer in coming to perfection than the first was; inasmuch as within three years after birth all the first crop had appeared above ground, whereas the second is not all up for close upon twenty years more, during nearly all which time one or other of its members has been in process of growth.

The time at which the various teeth of the first and second dentition are "cut," as it is termed, varies considerably. The earliest tooth to appear above the gum in the first or tem-

porary set are the lower central incisors. This takes place about the seventh or eighth month of infant life. In a week or two those of the upper jaw succeed them. The lateral incisors of the upper jaw next appear about the eighth or ninth month, and those of the lower jaw quickly follow. The anterior lower molars are cut from the twelfth to the sixteenth month, and immediately after them come the corresponding teeth in the upper jaw. During the seventeenth or eighteenth month the canines appear, generally those in the upper jaw first, and before the age of two and a half years the second milk molars generally commence to make their appearance, thus completing the temporary set of teeth.

The second set generally begins to appear about the age of seven years, by the first permanent molars being then cut. These are followed by the permanent central incisors at eight, the lateral incisors at nine, the first bicuspids at ten, the second at eleven, the canines at twelve, the second molars at thirteen, and the third molars at about twenty or twenty-one years of age. Previous to the shedding of the milk or first teeth, their fangs become absorbed by a process of what is termed cell proliferation.

No death of the fang nor obliteration of the vessels of the milk tooth occurs, but the remains of its pulp unite with granulations formed near it, and the growing tooth of the second set in the end pushes out what remains of its predecessor (5).

The structure of the three substances mentioned as entering into the formation of a tooth is peculiar, and all of them different from each other.

Dentine, or the body of the tooth, is composed of an infinite number of excessively minute tubes, the walls of which consist of something like bone. These tubes are arranged so as to lie with one end opening at the centre of the tooth, the other terminating at its external surface. Each of these tubes measures in the diameter of its bore about $\frac{1}{10000}$th of an inch, and contains a delicate prolongation from the pulp termed a dentinal fibre. The use of them seems to be in maintaining the vitality of the tooth, by drawing nourishment from the vessels running along the central cavity found in each tooth; and perhaps the fibre or small cord-like body described as occupying each of the small tubes may contain minute nervous filaments, and thus

serve to endow the dentine with a certain amount of sensitiveness (8).

Enamel consists of a collection of minute, dense, and excessively hard columns, closely packed together, and standing upon the surface of the dentine, where that substance is exposed within the mouth, and for which they constitute merely a mechanically protective covering. The general bearing of the enamel columns is at right angles to that portion of the surface upon which they are placed; so that those on the apex of a tooth stand vertically, while those applied to its sides lie horizontally.

Cement is a substance closely resembling ordinary true bone, and acts in the double capacity of assisting the central cavity of the tooth in affording nourishment to the dentine, and as a bond of union between the root of the tooth and its socket. The cement is more largely furnished with the means of deriving a supply of nourishment from the adjoining blood-vessels than the dentine; and as the centre of the tooth and the surface of its fang are thus provided with the means of sustenance, its vital powers are sufficiently, although feebly maintained.

Two other structures may also be here mentioned as forming constituents of a tooth—the Cuticula dentis, or a thin horny layer investing the enamel of a young tooth, but which soon disappears, and the soft central portion or Pulp, being the vascular and nervous matrix of the dentine, and remains of the original tooth papilla. The vessels and nerves of the tooth are contained by the pulp, and from it proceed the dentinal fibres occupying the tubuli of the dentine.

Whenever any of these three substances are defective or weaker than usual, they are, owing to the small amount of life at best possessed by them, more prone to disease and destruction. In their healthy condition, nature has provided well against the trying circumstances these organs are necessarily exposed to in such a locality as the mouth, not to speak of the heavy work they are sometimes doomed to undergo. But if disease, or even only delicate health, does overtake a tooth, the combined effect of this, and all the evils to which it becomes exposed, speedily result in death and subsequent decomposition or decay of its substance, constituting what is termed "dental caries." The substance of the

tooth is in this way destroyed, broken down, and removed; the central canal largely supplied with nerves as well as blood-vessels, and the cement substance, also largely endowed with sensation, either or both become encroached upon; acute pain is the result, and toothache in its true form is produced.

CHAPTER III.

GENERAL ANATOMY OF THE MAXILLARY APPARATUS.

THE anatomy of the dental system cannot be well described or thoroughly understood without taking into account the anatomy of all those structures which, besides the teeth, are involved in the performance of mastication. These structures include the Bones entering into the formation of the upper and lower jaw, the Muscles moving the lower jaw, the Nerves and Blood-vessels supplying these parts, and the Integument covering them inside the mouth.

UPPER AND LOWER MAXILLARY BONES AND TEETH.

What is termed the upper jaw is formed by the junction of two separate bones, one for each side, and termed the right and left Superior Maxillæ or maxillary bones. Each of these bones contains eight teeth in the adult subject, namely, one central incisor, one lateral inci-

sor, one canine, two bicuspids, and three molars. These two bones articulate with each other in the middle line of the face, and from their large extent assist in the formation of the orbit, the nose, the cheeks, and the palate. The superior maxillary bone is very irregular in shape. It may be described as possessing an external surface—that upon which the cheek rests; an internal surface—that applied to the corresponding surface of the bone of the opposite side: and a posterior surface, forming the tuberosity which rounds off the bone behind. Above it presents a smooth flat surface, which forms part of the floor of the orbit. Below it presents an arched surface, entering into the formation of the palate, and having the upper teeth projecting downwards from its external border. Partly enclosed by all these surfaces a large hollow space exists in the body of the bone, termed the maxillary antrum, or antrum of Highmore. This cavity is of a triangular form, and its closure is completed by certain other bones entering into the formation of the skull. The superior maxillary bone gives passage to a branch of the fifth pair of nerves through a small round opening immediately under the orbit, and enters into the

formation of the nose in conjunction with the same bone on the opposite side.

The lower jaw is formed by an arched or horse-shoe shaped bone, termed the Inferior Maxilla or inferior maxillary bone. It is divided into a horizontal portion, containing the lower teeth, and an upright or ascending portion, terminating in the joint or temporo-maxillary articulation at each side. These portions are named respectively the horizontal and the ascending ramus of each side, the chin being considered as placed between them in front. The ascending ramus on each side is bounded superiorly by two structures, viz., in front by a sharp and thin process of bone termed the coronoid process, and behind by another process of a thick and somewhat tuberose aspect, termed the condyle, and constituting the articular portion of this bone. Between the coronoid process in front and the condyle behind, the flat substance of the ascending ramus is hollowed into a deep notch called the sigmoid notch. Proceeding downwards, we find the internal aspect of the ascending ramus perforated by a canal opening downwards into the substance of the bone. This is the inferior dental foramen for the transmission of a nerve

and blood-vessels into the body of the bone for the supply of the contained teeth, &c. At its lower and back part, the angle formed by the commencement of the horizontal ramus is termed the Angle of the jaw, and passing forwards from this on each side to the chin, is what has been already described as the horizontal ramus. Midway between the angle and the chin on each side is a small round opening—the mental foramen—and marking the centre of the chin is a somewhat elevated ridge denominated the Symphysis of the lower jaw.

Such, in general terms, and without entering upon any detailed description, are the more characteristic features of the upper and lower maxillæ.

The Alveolar cavities or sockets in which the teeth are implanted in these bones, consist of a series of pits arranged along the free border of each jaw, and into which the fangs of the teeth are accurately fitted. This accuracy of fitting along with the curved form assumed by the fangs, and the union established by the membranous structures situated between them and the sockets, explain the remarkably firm manner in which the teeth are found fixed in the jaws.

Each alveolar cavity—whether for the single root of such teeth as those having only one fang, or for any one of the fangs of teeth having several—is enclosed by four walls, one situated towards the lips or cheeks, and one towards the tongue or palate, as the case may be in the upper or lower jaw; and besides these, two transverse walls or partitions exist, separating each alveolar cavity from the others. All these walls are perforated by innumerable minute openings for the transmission of vessels, &c., to the outside of the fang, and at the deepest part of the sockets several larger openings exist for the entrance of the nerves and blood-vessels to the pulp cavities of the teeth. The transverse walls or partitions are much less dense in their structure than either the external or internal walls; and the external wall is in nearly all the teeth much thinner and weaker than the internal one.

These peculiarities in the alveolar cavities are important to be kept in mind with reference to extraction of the contained teeth. The exact adaptation of the alveolar walls to the form of the fang lodged within them—especially when considered along with the curvature so generally

assumed by these latter—will at once indicate the impossibility of removing the teeth from their sockets by a straight pull; a difficulty which is moreover increased by the spiral or screw-like tendency indicated in the form of each fang, if examined by looking at it in the direction of its long axis. On the other hand, the thinness of the external alveolar wall—coupled with the fact that, like the stones forming an arch, the fangs of all teeth are thickest on their outer aspect—indicates that a force applied so as to dislodge the teeth in an outward direction, will tend very materially to facilitate their removal. In the same manner, the soft and spongy texture of the transverse partitions of the alveolar ridge renders it apparent how, in using the elevator or tooth-punch, a root or stump will be easily extruded, on these walls or partitions yielding before the power of such an instrument when properly directed. The disadvantages, again, attending an acquaintance with such matters are too obvious to require any comment here.

The anatomical configuration of the teeth themselves, implanted in the upper and lower maxillæ, differs very much among the individual

members of the series, and according as they are temporary or permanent. The four incisors of the upper jaw are single-fanged teeth, and they differ from the corresponding teeth of the lower jaw, inasmuch as, while the upper ones have round fusiform fangs, the lower ones have the fang very much flattened from side to side. The eye-teeth or Canines, possess longer and stronger fangs than any of the other teeth. The form of these fangs is a somewhat flattened cone, frequently marked on the sides by a deep groove or furrow—a construction rendering their fixation in the jaw very secure. The Bicuspids in the upper jaw—two in number on each side—have their fangs either single and very much flattened from side to side, or this flattening so pronounced in the middle as to divide the otherwise single fang longitudinally; thus leading to the tooth having two fangs—one externally and one internally—both in such cases being generally round and attenuated. In the lower jaw, the corresponding teeth have simple round tapering fangs, sometimes of considerable length. The Molar teeth of the upper differ in an important respect from those of the lower jaw. The upper molars have three fangs; the lower

have only two. The three fangs of the upper molars are arranged so that two shall be situated next the cheek—one fang behind the other—and the third fang placed inside the others and directed towards the palate. In this manner the upper molars possess one palatal and two buccal or cheek fangs, the palatal being the largest, and next to that the anterior buccal fang. The lower molars possess two fangs, one placed behind the other, and of these the anterior is markedly the largest. The fangs of the lower are generally much broader and longer than those of the upper molar teeth.

A difference has been stated as existing between the form of the temporary contrasted with that of the permanent teeth. This is not confined merely to the size of the permanent teeth being so much greater than that of the deciduous set; but the temporary teeth are peculiar in two respects—first, they have the crown very much contracted at its junction with the fang or fangs, so as to cause a bulging or shoulder at that part where the tooth rests upon the gum; and second, in all the multiple-fanged teeth in the temporary set, the fangs are spread much more widely, and their separation

increases much more rapidly towards their extremities than is the case with similar teeth in the permanent series. Both these peculiarities will be found of some service to be kept in mind in grasping a temporary tooth and in proceeding to its extraction.

MAXILLARY MUSCLES AND TEMPORO-MAXILLARY ARTICULATION.

Before proceeding to describe the muscles moving the lower jaw, it may be stated that its movements are those of—1*st*, depression, by which the mouth is opened; 2*d*, elevation, by which it is closed; 3*d*, a backward and forward movement; and 4*th*, a lateral movement, or a motion from side to side. In order that motions of this kind should be practicable, the joint or articulation of the lower jaw with the temporal bone is found to present certain peculiarities. This joint is formed by the Condyle of the lower jaw articulating with a hollow in the temporal bone—termed the Glenoid fossa. The ligaments by which the joint is held together are three in number, namely, the External lateral ligament, consisting of a band of fibres covering in the articulation on its outer aspect; the Internal

lateral ligament, a fibrous band extending from a structure in the neighbourhood of the joint—termed the Spinous Process of the sphenoid bone—downwards until it is inserted midway down the ascending ramus on its inner side, at the inferior dental foramen; and the Capsular ligament—consisting of a few ligamentous fibres passing from the edge of the glenoid cavity to the inner and back part of the neck of the condyle. Between the surface of the glenoid cavity and that of the condyle, there is interposed a flat oval disc of cartilage termed the Inter-articular Cartilage. This cartilage is freely movable, shifting its place with the various motions of the joint, and is lubricated on its upper and under surfaces by two structures placed one in each of these two situations, and termed synovial Membranes,—their purpose being to secrete an oily fluid called Synovia. Such is, in general terms, the construction of the temporo-maxillary articulation at each extremity of the lower jaw in man. In grass-feeding animals and others of the kind much freedom of motion in all directions exists in this articulation. In flesh feeders, again, it is limited mostly to a movement upward and downward.

In all the structure of the joint is such that, instead of a mere rubbing motion between the surfaces of the condyle and glenoid cavity, there is substituted much of a rolling motion, an arrangement which has been shown to account for the obliquity of the condyles to the transverse axis of the jaw (31).

Muscles are bundles of fleshy fibres constituting the organs by which the movements of joints are effected. Their size varies to a great extent, according to the power they have to exercise; and their colour and consistence is that of what we recognise as flesh. The maxillary muscles may be divided into two groups—those designed for closing and those designed for opening the jaws. The group to which attention is here chiefly required is that of the muscles closing the jaws, as the muscles employed in opening them are not confined in their action to this purpose alone, but are connected as well with the movement of other structures in front of the neck. They may therefore be dismissed by merely stating that they are attached to the inner surface of the horizontal ramus of the lower jaw, principally to the inner surface of that part forming the

chin; that they are in a great measure associated with the movements of the tongue and other parts, and that they form to a considerable extent the floor of the mouth.

The other muscles, those adapted for closing the jaws, form the more active agents in the process of mastication, and are five in number, namely, the Masseter, the Buccinator, the External Pterygoid, the Internal Pterygoid, and the Temporal Muscles.

The masseter is a thick square-shaped muscle, composed of a deep and superficial layer, and arises from the superior maxilla, the malar bone, and the zygoma; from these it descends to the ascending ramus and angle of the lower jaw, on the outer side of which it is inserted. This muscle, from its situation and direction, closes the lower molar teeth with great power against those of the upper jaw. The buccinator is a muscle acting principally on the cheeks, and enabling them to assist the jaws during mastication. It arises from the alveolar surface of the superior maxilla and from a corresponding part of the lower jaw, over a space extending from the pterygo-maxillary ligament behind to the bicuspid teeth in front. Its fibres converge

until they meet and cross each other near the angle of the mouth. The external pterygoid muscle arises by two heads; one from a structure termed the pterygoid ridge of the sphenoid bone the other from the external pterygoid plate of that bone and part of the palate bone. It passes backwards to be inserted into the ascending ramus of the lower jaw immediately under the condyle. This muscle acts as a grinding and bruising muscle, by drawing the lower jaw forward upon the upper. The internal pterygoid is a thick muscle arising near the external pterygoid from the pterygoid fossa, and descends to be inserted on the inner surface of the ascending ramus near the angle of the jaw. The temporal is a somewhat extensive fan-shaped muscle arising over a large portion of the side of the head; its fibres converging to be inserted by a strong tendinous attachment into the coronoid process and along the inner surface of the ascending ramus. Its action is that of closing the lower against the upper jaw.

All these muscles act in concert during mastication, and their combined action results in the rotatory or grinding movement by which the food is crushed and triturated between the teeth.

BLOOD-VESSELS SUPPLYING THE TEETH AND ADJACENT STRUCTURES.

The blood-vessels in an animal body are composed of Arteries, or those vessels conveying the blood from the heart to every part of the body; of Veins, or those vessels returning the blood from these parts to the heart; and of Capillary vessels, or those minute branches which ramify through the tissues, and form the ultimate channels through which the blood passes from the arteries into the veins. The arteries commence at the heart by a large main trunk, termed the aorta; from this trunk branches are given off, and from these again other branches, and so on until the capillaries are arrived at, and where the principal functions of the blood are performed.

It will be sufficient, in describing the arteries of the teeth, to go back to that branch termed the Carotid artery. This artery divides into two minor branches—the External and the Internal carotids. The external carotid ascends along the side of the neck, and behind the ascending ramus of the lower jaw, until passing upwards it terminates by being distributed over

the surface of one side of the head. This external carotid gives off many branches during its course, and it is with one of these we have here to deal, namely, the Internal Maxillary artery.

This artery rises from the external carotid, at a point on a level with the opening of the ear. It then passes forward, dips behind the condyle of the lower jaw, and turns inwards between the two heads of the external pterygoid muscle; while passing within the condyloid portion of the lower jaw it gives off a branch to supply the teeth of the lower jaw, the Inferior dental artery. This artery passes downwards to the dental foramen, and proceeds along its canal until it reaches the mental foramen, where it subdivides into two branches, one of which escapes by the mental foramen, and is distributed on the surface of the chin and face; the other branch continuing its course forwards within the substance of the jaw, to supply the lower incisor teeth. On the internal maxillary passing between the two heads of the pterygoid muscle, it gives off another branch for the supply of the teeth in the upper jaw, the Superior dental artery. This artery descends upon the

back of the tuberosity of the superior maxillary bone, and sends a number of branches through several small openings there, to supply the posterior teeth, and to be distributed within the antrum. Another branch of the internal maxillary passes through the canal described as situated immediately beneath the orbit in the upper jaw, the Infra-orbital artery. This artery, as it runs along that canal, sends branches downwards, some of them to supply the lining membrane of the antrum, and some of them, the anterior dental arteries, to supply the incisors and teeth in the fore part of the upper maxilla. All these arteries interlace and communicate with each other and with adjacent arteries in a very general and extensive manner; so that should one of them be obliterated, the supply of blood to any part would be but little impeded. Each artery has, generally speaking, a corresponding vein or veins; but sometimes it becomes difficult to follow out this arrangement. The veins carrying the blood from the head and corresponding to the carotid arteries, are termed the Internal and External Jugular veins.

Impediment or obstruction to the circulation

in the arteries and veins of the neck produces a condition of the brain tending to cause insensibility from impairment of the circulation there. Certain positions of the head may lead to these results, at least in some individuals—a fact explaining the occurrence of faintness in some operations on the mouth not in themselves painful, but in which the head has been for example thrown back for any length of time &c. (27).

NERVES SUPPLYING THE UPPER AND LOWER MAXILLÆ AND TEETH.

The nervous system consists of the brain, the spinal cord, and numerous white bands or filaments of nervous substances, termed nerves. In addition to these is what is called the sympathetic system of nerves, a series of numerous small masses of nervous matter, termed Ganglia, and filaments communicating with them and with the brain and spinal cord. Thirty-one pairs of spinal nerves are described by anatomists, and nine pairs of cranial nerves, or of nerves arising from the brain. Of these cranial nerves the Fifth pair is that supplying the teeth and dental apparatus generally. The fifth pair of nerves

is also termed the Trifacial nerve, because three of its principal branches terminate by being distributed from three different foramina opening in the bones of the face, namely, the Supra-orbital, the Infra-orbital, and the Mental foramina.

All the spinal nerves are subservient both to sensation and motion. Some of the cranial nerves, on the other hand, convey only sensory impressions, while others are only nerves of motion. The fifth pair, however, combines both these functions. At its origin, in the brain, it consists of two portions, termed anterior and posterior. Its anterior portion is motor, and, passing forwards, subdivides, and is distributed to the maxillary muscles. Its posterior portion assumes the form of three branches, termed the Ophthalmic, the Superior Maxillary, and the Inferior Maxillary nerves. The ophthalmic nerve emerges above the orbit; the superior maxillary immediately under the orbit, through the infra-orbital canal, in the superior maxilla; and the inferior maxillary emerges by one branch through the mental foramen, in the lower jaw. The branches principally associated with the teeth are the superior maxillary nerve

and that branch of the inferior maxillary emerging through the mental foramen, the inferior dental nerve. Just as it enters the infra-orbital canal, the superior maxillary nerve sends down several branches, which enter the foramina on the posterior surface of the tuberosity of the superior maxilla, and supply the posterior teeth of the upper jaw,—and while passing along this canal it sends off other branches, the middle and anterior dental branches, which pass down within the antrum to supply the remaining upper teeth. The inferior dental nerve passes down between the two pterygoid muscles, and entering the dental foramen on the inner aspect of the ascending ramus, supplies the teeth of the lower jaw. It passes along the canal in that bone, close to the extremities of the roots of the teeth, from the dental to the mental foramen; at which latter, it divides into two branches, one passing out there, and being distributed to the integuments in the cheeks and chin, the other passing forward to supply the incisor teeth.

These nerves communicate freely with other nerves in their vicinity, and in this way account for the irritation and pain set up

in neighbouringing parts from disease of the teeth.

MUCOUS MEMBRANE OF THE MOUTH, &c.

The entire cavity of the mouth is, in common with other portions of the alimentary canal, lined by a structure analogous to the skin covering the external surface of the body, and termed Mucous Membrane. What is termed the Gum, consists of a dense and hard form of mucous membrane, closely adherent to the jaws, and embracing, without being attached to, the necks of the teeth. The gum is endowed with very little sensibility. It is reflected into and becomes continuous with the membranes lining the interior of the alveolar cavities. Several bodies, termed Salivary Glands, are associated with the mucous membrane of the mouth, and aid in supplying moisture, in the form of saliva, to that cavity. These glands are three in number on each side, namely, the Parotid gland, the largest of the three, situated in the neighbourhood of the ascending ramus of the jaw, and opening by a duct, called the duct of Stenon, on the internal surface of the cheek, opposite the second upper

molar tooth; the Sub-maxillary gland, situated under the horizontal ramus at its back part, and opening into the mouth by a duct, termed Wharton's duct, terminating under and near the front part of the tongue; and the Sub-lingual gland, situated under the tongue on each side, and opening by several small outlets near the orifice of Wharton's duct. The whole mucous membrane of the mouth, together with the salivary glands, sympathises largely with the teeth in their diseased conditions, and becomes the seat of many painful affections in irritation of the parts arising from this cause.

In many cases a large deposit of calcareous matter takes place from the saliva, and attaches itself in thick masses to the crowns, or any exposed portions of the teeth. This deposit is termed Tartar. The operation known as Scaling consists in the removal of this substance from the surface—generally the buccal or lingual surface—of the teeth. Instruments for the purpose, termed Scalers, are to be had in a variety of forms. They are used by inserting the point into or under the masses of tartar, and scraping, or if in large quantity, lift-

ing it away, taking care not to loosen the teeth in so doing. Any roughness left after scaling may be removed by rubbing the exposed enamel with powdered chalk on a piece of cane or pointed wood.

CHAPTER IV.

DENTITION: ITS DISORDERS AND THEIR TREATMENT.

DENTITION, in the most common acceptation of the word, appears to be too frequently confined to that period at which the temporary teeth make their appearance above the gum; and in this restricted sense of the term, we have constant reference made to a number of affections occurring during infancy, and attributed to the morbid influence of, exclusively, the eruptive stage of this process, under the various names of teething, cutting the teeth, &c. &c., all having regard to the penetration of the tissue enclosing the tooth—as if this were effected, not according to a vital process, but by mechanical force—while the other stages, exhibiting less obvious phenomena, are never taken into account at all. It is of importance, in the consideration of this subject, to bear in mind that the process of dentition, being in all its stages a natural one

regulated by relatively the same physiological laws as other healthy actions, ought to proceed without constitutional disturbance ; that it does so in all animals, so far as we know, with the exception of man ; and that, in his case, when disturbance does take place, it is to be regarded as arising from some peculiar abnormal condition of the parts concerned in, and not at all as an inherent effect of, the process itself (20).

The structures concerned in dentition are originally adapted for its occurrence, and it is inconsistent with what we know to be the case in analogous instances of development, that any of the steps essentially necessary in the process—such as the penetration of the gum—should occasion a great amount of distress. But an important source of error, and one calculated to lead to much misapprehension on this subject, exists in the fact, that from the greater susceptibility at this age to impressions of any kind, sometimes to those of a very slight nature, considerable constitutional disturbance, altogether apart from this cause, is of very common occurrence ; and, although certainly not in every case due to this process, yet the eruptive stage of dentition offering something like a plausible

explanation of suffering, an unfavourable impression generally prevails regarding it, and affections are imputed to its agency, which might, in many cases, be traced to an entirely different origin. Attention, however, being arrested by what appears to be so evident a cause of uneasiness, all treatment is at once turned in that direction, and the true cause of the disorder probably overlooked.

While these remarks are advanced as illustrative of the misconception prevailing in reference to the danger resulting from dentition, it is not meant to dispute the fact that important symptoms may exhibit themselves in connection with this process as it occurs in man, but rather to point out that too great anxiety exists with regard to it as a necessary, an unavoidable, cause of suffering; an opinion, if not arising from, at least increased by the obscurity and uncertainty involving the whole process, and extending to those principles upon which its treatment requires to be based.

In considering the nature of the symptoms attending laborious dentition, we must look principally to the organic condition of those textures implicated in the action going on; re-

collecting that the teeth, during their development and rapid growth, while acting in one sense as foreign and partly inorganic bodies within the gum, are endowed with a very high degree of vascularity and sensation, so that whatever pressure they may exert on contiguous parts, re-acts upon themselves with still severer effect, that again being aggravated in its consequences by the condition of the whole nervous system at this period of life. Whatever complications may arise as secondary consequences of dentition, pain seems to be its most frequent as well as its most simple accompaniment, and it is to the immediate causes of this condition, as mainly productive in its results of those maladies observed to be more common about this age, that attention has been so often directed. Locally, the inconvenience seldom exceeds mere irritation; that, however, sometimes increasing to a considerable extent; and although almost universally asserted, it seems not to be satisfactorily established, that this arises merely from the cutting or penetration of the teeth through the superincumbent tissues, but also from other circumstances connected with the development of these organs during the first dentition (20). In

children at this age, the manifestations of pain, when it is present, are unmistakable, although it becomes a very difficult matter in many cases to assign to such pain an exact locality. Pain, when associated with the tooth germs, may be either of a neuralgic or inflammatory nature. Where it seems transitory or intermittent, it is probably neuralgic; where it is persistent, and especially if accompanied by swelling, heat, or redness of any part of the gums, inflammatory action is, of course, evident. It is in either case, however, comparatively unimportant, so long as the evil is confined to the mouth. When it reacts upon the general system, and leads to functional derangement, interference of some kind becomes necessary.

If no indications of inflammation exist in the mouth—and no tooth may, according to the natural course of events, be expected to appear for a considerable time—some substance should be given the child to rub against its gums, care being taken that such substance should not be of a nature calculated to lead to danger by breaking or passing into the mouth—such as crusts of bread, small keys, coins, and the like. In this way, two indications may be fulfilled,

namely, first, an increased flow of saliva is produced, and a derivative action, as well as a kind of fomentation, to the parts is obtained; and second, the alveoli and gums seem to be rendered thinner by such means, probably by the friction and pressure accelerating their absorption.

Where, on the other hand, the gum is red or hot, or appears tense and stretched by the pressure of the crown of the tooth beneath, more active measures may be employed. The chief of these is what is termed Scarification. This consists in making an incision down upon the growing tooth, the object being to relieve congestion existing in the highly vascular tissues concerned, and sometimes to facilitate the egress of the tooth, by dividing any bands or bridles of tough mucous membrane opposing its escape. The method of performing this little operation in the easiest manner will be found to be that of seizing the affected part of the gum betwixt the thumb and forefinger of the left hand, and by means of a sharp-pointed, curved, and somewhat short bistoury—that known as Syme's abscess knife being the most suitable—making a crucial incision completely through the tissues

covering the tooth. There seems little doubt, however, that although this proceeding may in one way be beneficial, in another it is possible to be injurious; because, while good results may follow in the manner already specified, yet the delicate structures involved in the still rudimentary condition of the tooth must be, to a certain extent, interfered with. It should, therefore, be adopted only as a last resource, and after mature consideration. Where apparently causeless convulsions, for example, occur during the active stage of dentition, or where the eruption of previous teeth has been uniformly attended with much suffering, less hesitation may be necessary; but in other cases some local evidence of irritation should always be present before having recourse to such practice. And one other point to be mentioned is, that some attention must be paid to those periods in the process of dentition when the various teeth may be naturally expected to make their appearance; because it is at such periods that this operation is most likely to be attended with benefit.

The temporary teeth are not subject to Irregularity in their arrangement. This, on the other hand, is a very common occurrence among

the members of the permanent set. The most marked forms of irregularity seem to occur in the front part of the dental series; generally among the teeth anterior to the bicuspids. Sometimes the irregularity is confined to mere crowding and displacement of the teeth in one or other jaw; sometimes it leads to more perceptible deformity, such as projection of the under teeth beyond the upper, leading in this way to the patient being what is termed underhung.

The treatment of dental irregularity consists of two kinds,—first, that of providing sufficient space to accommodate the teeth in their regular order; and, second, that of forcing them into their natural situations when such space has been provided. The first step, then, being to obtain space for the displaced teeth, it generally becomes necessary for this purpose to extract one or more at some part of the mouth. The question is, which teeth to select for removal? and the following rules may serve so far as a guide in this respect.

1*st*, Where the corresponding tooth of the temporary set is present, it of course is to be at once extracted; and where any of the temporary

series seem to be directly in the way of any of the permanent set which have just appeared, such temporary teeth should be removed.

2*d*, The canine teeth not being renewed until those situated behind them, the bicuspids, have appeared, are subject to great irregularity in position; but of all other teeth they resume their place with the least amount of interference. If, however, the anterior bicuspid threatens to leave too little space for the canine, the remaining temporary molars of that side should be extracted, and the temporary canine preserved as long as possible, as this tooth serves to keep a space vacant for its expected permanent successor.

3*d*, Where all the temporary teeth are already removed, the first or anterior permanent molar is the next to be sacrificed, as this, of all the permanent set, is the one most subject to be lost.

4*th*, Lastly, in such cases as those where it seems hopeless to expect that sufficient space will be gained by the removal of teeth at a distance from those to be regulated, any decayed or otherwise diseased tooth directly in the way of the misplaced one, or such of these irregular

teeth themselves as seem least serviceable, and most likely to facilitate the re-arrangement of the others, must be removed; always bearing in mind, that the canines are perhaps the most durable, and in some respects consequently the most valuable, teeth in the whole series, and the first molars the least so.

When sufficient space has been gained, the displaced teeth may be forced into position in a variety of ways. The principle upon which all of them, however, are founded, consists in a plate of metal, or other material, being accurately fitted to the palate or jaw, and so securely fastened in its place as to afford a fixed point from which the displaced teeth may be acted upon, either by being pressed into their place by little wedges, and such like means, or being dragged into it by the use of ligatures; considerable time—some months generally—being required for the accomplishment of such an object, in whatever mode it may be attempted.

As the making of such plates requires all the experience of a regular mechanical dentist, it seems unnecessary here to dilate upon their construction. What chiefly devolves upon the surgical practitioner is, to see that such plates,

when supplied, are continuously worn, and to impress upon the mind of the patient and attendants the length of time and the possibly numerous visits required for effecting those ends for which their use is intended.

CHAPTER V.

DENTAL CARIES, NECROSIS, AND EXOSTOSIS; ALVEOLAR ABSCESS AND FUNGUS OF THE PULP.

THE pathological conditions under which the dental tissues are met with, naturally seem to arrange themselves under two separate heads. First, those where a morbid development of new tissue occurs; and second, those where the normal tissues of a tooth become deteriorated or destroyed. Exostosis of the fang may serve to exemplify the first, and dental caries may be taken as illustrative of the second of these divisions.

The ordinary characters of caries are in general familiarly understood. It consists in a diseased condition of the dental tissues, especially of the Dentine, whereby it becomes disintegrated and disappears, leaving a large, softened, and discoloured cavity in the tooth, which, when left to itself, ends in the crumbling down, and total loss of the whole crown, and frequently of the

greater portion of the fangs. At its earliest stages this affection usually attracts little or no attention. This arises from the small amount of sensibility existing in the dentine of a previously healthy tooth. Considerable morbid change may here, however, as in other tissues, take place without pain, and its occurrence thus be overlooked. Generally a slight discoloration exists at the site of the disease from a very early period. A dark spot or streak appears on some part of the enamel, very often at some part where it is thinnest, such as in the hollows of the crown of a molar tooth, or where the enamel becomes attenuated as it approaches the fang. Another very common site is in the incisors of the upper jaw where their lateral surfaces are in contact. At such points the flaw becomes more and more apparent; the enamel assumes a friable and undermined appearance; and at some unexpected moment, this structure gives way more or less and reveals the altered dentine below; a state of matters probably up to this time unsuspected. From this period the distinguishing characteristic of dental caries, in contrast with that of other osseous tissues, is manifest, namely, the

essential part played by chemical action from without, in addition to those changes going on from within—vital becoming combined with mere chemical action, and the tissues of the tooth being literally decomposed. Pathological changes thus render the substances of the tooth open to the attacks of chemical agencies existing in the secretions of the mouth, and by these last the calcareous matters of the diseased structures are dissolved and washed away. The structure chiefly and most obviously affected is generally the dentine. Very soon, however, the enamel suffers, and frequently the cement also becomes involved in the disease. Sometimes these two latter structures appear to be first affected. There seems less reason to doubt the likelihood of this being occasionally the case with the cement, but the nearly inorganic nature of the enamel would almost preclude the idea of any lesions primarily occurring there being of a vital nature. More probably, where this substance is affected in the first instance, it is so traumatically rather than idiopathically, and does no more than favour or excite the commencement of true caries in the dentine beneath.

Besides these somewhat anomalous characters presented by dental caries during its progress in individual teeth, there are certain peculiarities manifested by it in the manner in which it spreads among the various members of the dental series. Certain teeth, such as the first lower molars, are much more liable to its attacks than others, and it generally attacks in a uniform manner corresponding teeth on both sides of the mouth. Frequently the disease suddenly commences and goes on in a series of successive attacks for some months, or even a few years, until a number of teeth have been destroyed, when it suddenly and inexplicably disappears, and perhaps recurs no more during a lifetime. At other times, in cases where one or two obviously defective or perhaps injured teeth exist in a mouth, caries will appear in some altogether unlooked for quarter, leaving the suspected teeth unmolested. Most commonly it prevails to the greatest extent in young persons, but its ravages sometimes commence almost as soon as the temporary teeth appear, and sometimes its first attack occurs only in advanced life.

Different theories have been advanced regard-

ing this peculiar disease; but unless it be considered as partaking of the character both of a constitutional affection and of a lesion produced by local causes, it seems difficult to account for its somewhat exceptional if not unique phenomena. According to one theory, dental caries is set down as an exclusively chemical process, a mere decomposition of the dental tissues. According to another, it is a purely vital action, consisting in gangrene or mortification of these tissues—neither view, however, seeming to be correct.

From what has been stated in another chapter regarding the development of the teeth, it will be recollected that they are originally formed from mucous membrane, that modification of skin which lines the alimentary canal from the mouth downwards. The germs of these organs were described as being developed from the groove found in the mucous membrane of the fœtal mouth. We must therefore consider teeth as dermal organs; organs analogous to such appendages as nails or hairs, and consequently we may naturally expect them to be subject to attacks of disease such as are associated with other dermal tissues. In this man-

ner, there is no reason for considering that dental decay is an exclusively chemical action; a mere decomposition of the substance of the tooth by the action of the oral fluids. Were this the case, all teeth would be equally affected, which we know does not occur. And even if, as has been advanced, such chemical action only occurred in exposed or defective dentine, we should find broken, or worn down, or obviously defective teeth suffering more than others; which, again, is far from being invariably the case. But if we admit the accession of disease as possible in *any* tooth, however healthy or well developed, we get rid of the difficulty, and obtain a sufficient explanation of many otherwise unaccountable facts connected with this subject. Indeed, if it be held that defective development is a necessary condition for the inroad of decay, we admit that at an earlier period of the tooth's existence, the vital functions of its tissues have undergone a lesion apart from the direct action of any external causes. And if development may thus be interfered with, that is, if the nutrition of a part can be arrested or altered during its growth, there appears little difficulty in extending the proposition to its nutrition at a later

period being liable to somewhat similar disturbance, leading to its vitality being diminished, and disease thus established without the intervention of any extraneous cause. The vitality of a fully developed tooth is now an undisputed fact; and being vital organs, they will be at any period subject to disease originating from within, as well as injuries occurring from without. Many phenomena, in the accession of dental caries, bear out such a statement. The carious portion of a tooth manifests its vitality in the increased sensitiveness possessed by it. In some cases, indeed, the enamel itself, where to all appearance perfectly sound, is exceedingly sensitive to the touch—here indicating vital endowments in a texture which of all others in the tooth might be presumed to be inorganic. The direct sequence of dental affections on various temporary conditions of the body, and of organs in no way directly associated with the teeth, is more than sufficient proof of this. The effects on them of many constitutional disorders—of mercury—of pregnancy—even of disorders of the nervous system, such as during insanity, clearly demonstrate how very much these organs are influenced by causes

which must act upon them not physically, but physiologically, and consistently explain away many or all the difficulties attaching to the older theories of dental caries.

The exact pathological nature of the disease has been much disputed, and is still but imperfectly understood. Of late, however, the advance in our knowledge of the laws of morbific change in other structures is calculated to assist in elucidating by an inferential mode of reasoning what here might be difficult to discover by actual demonstration. While setting aside as altogether untenable the old view of dental caries being a mere mechanico-chemical and not a vital lesion, it must be acceded that the termination of the process at least leads to death of a portion of dental tissue, which then becomes subject to physical changes. The question of importance is, how does this death of the tissue occur: what is the nature of the diseased action producing it? Such an inquiry can only be answered through the medium of certain widespread facts presented in what is at this date known of pathological anatomy generally.

In order to maintain any tissue in a state of

perfect health, it is essential that its vital energy should continue undisturbed. Whenever this is so interfered with that the nutrition—in other words, the sustaining power of living tissue—is diminished, we have the first phase of morbid action or disease established. This is now held to be the explanation of what is called the inflammatory process, and is brought about in two totally distinct ways—viz., either by the direct operation of a noxious agent upon the tissues, or indirectly through the medium of the nervous system (37). Under such conditions we have a tissue exhibiting all the different degrees of diminished vital power shading off from that of health through those of inflammatory hypertrophy, granulation, suppuration, and sloughing or death, each being a phase of formative action less and less perfect until its total extinction. What was formerly considered as the deposit of a specific material, viz., tubercle, affords an illustration which may here be quoted. In a general sense, pulmonary phthisis may be said to commence with induration from hypertrophy of existing tissues, followed by disintegration and cavern formation (38). The same agency will produce induration, con-

sisting of the same materials—in one case constituting the induration of chronic pneumonia or bronchitis, in another that of phthisis—in all the agency being that of irritation; only in the case of phthisis supervening upon a pre-existing tendency to particular results. Now in the case of dental caries something very similar appears to occur. We have induration proceeding from hypertrophy of normal material, ending in disintegration and cavern formation. We have induration, or rather solidification, existing in certain cases with no such subsequent results, but these, like the example already quoted, seem to be those where there is no *tendency* to assume the special morbid action. There may in the instance of dental caries be supposed to be superadded, the chemical action exercised on dead or feebly vitalised tissue by the oral fluids, but this is a matter open to some considerable doubt in the sense of a truly pathological element in the disease. It is more an event occurring when the disease has already run its course and terminated in death of the part.

That condensation of the tissues takes place in dental caries has been known for long. Its

occurrence has been explained as an effort of nature to interpose a barrier between the sound and decayed portions of the tooth—as such consolidated tissue is always found investing, and at a little distance from, the carious cavity. But another view may be taken of this appearance, and one which as yet seems to have been overlooked. This is its being due to the condition of inflammatory hypertrophy already described as occurring in other tissues and preceding their disintegration. In caries affecting bones, the marble-like induration surrounding it has been supposed to cut off the vital supply from that part, and so to lead to its destruction. Whether this be the correct explanation of the process, or whether the actual disintegration of part of the affected bone be but an advanced phase of that irritation or morbid action leading in the first stage to increased but imperfect cell-development, and manifesting, according to degree, the phenomena of granulation, pus formation, and death of the tissue—it is somewhat difficult to determine. But there appears no reason to doubt that in either or both ways certain of the phenomena of dental decay may result.

We must conclude, then, that this disease may be, and generally is, the result of a vital action casually set up in the dental tissues, whether these tissues be congenitally defective or not. Where defect does exist, dental decay may be favoured and accelerated by such circumstances; but it does not follow that decay cannot attack a perfectly sound and well-developed tooth.

In this way dental caries, like other diseases, may be due either to a central or an extraneous cause. Thus in the eye, the cornea may become ulcerated either from external injury or from the effects of a constitutional taint, or from division of certain nerves; but where a mere local cause of dental decay is at work, as in disordered secretions within the mouth, either its effects will not be confined to one or two teeth, but will extend equally to all without distinction, or it will confine itself to such individual teeth as come, in some obviously exceptional manner, under its influence. Dental caries, however, explained exclusively on such hypothesis, would fall more correctly under the head of chemical decomposition than of disease considered as a pathological lesion, and fails to account for the

vital phenomena displayed in the selective progress, the various morbid changes, remarkable intermissions, &c., in decay, already alluded to.

While the first molars seem to be the teeth most liable to caries, the lower incisors are those least so. No satisfactory explanation of the prevalence of caries in certain teeth more than in others has ever been given; but the immunity of the lower incisors may probably be accounted for by the presence of the saliva lodging in larger quantities in their vicinity. And this is a circumstance deserving of some attention. Wherever the saliva lodges to the greatest extent, there we find the largest deposit of what is known as Tartar or salivary calculus, as it in reality is; and wherever such substance is found to be most abundant, there decay will be found to be most rare (21). This is well exemplified in the case of the lower incisors. Here the saliva lodges continuously, and in considerable quantity; and the result is that the greatest accumulations of tartar are always to be met with in this locality. Now, of all other teeth the lower incisors are least affected with caries, those of the upper jaw being, on the other hand, very liable to this disease. The explanation

here, then, seems to afford an argument in favour of the chemical theory of decay—viz., that the peculiar alkaline character of the saliva neutralises any acid which might be otherwise conducive to the loss of these teeth. And in this way possibly it may serve as a defence in some measure against local agencies of a character destructive to these organs when defective or in any other way liable to decay excited by a local cause.

Such, in general terms, appears to be the nature of dental caries, by far the most common disease to which the human teeth are liable, and the loss occasioned by which is so great. The question may be asked, If dental caries be a true pathological lesion, why is it that no healing process is set up by nature, so that the ravages of such disease should be at least in some cases spontaneously arrested, if not repaired? That such an attempt is made by nature has been mentioned by some to be the case. The condensation of the dentine which occurs around a carious cavity has been viewed as an effort on the part of nature to limit the extension of the disease, and may in a secondary capacity be so. But in the majority of cases among other organs

than the teeth, it must be recollected that whatever arrestive or healing effort may be made by nature, it would have little chance of being successful were the diseased part subjected to the same exposure as is the surface of a carious cavity in a tooth. Here the diseased action is kept up, as would be that of an ulcer in the skin, unless properly protected; and it is with such a view, and on such a principle, that in cases of dental decay the operation of stopping or filling the tooth is adopted.

Besides caries, two other affections of the teeth render their removal in many cases necessary. From various causes, such as blows, inflammation of the alveoli, &c., a tooth may be deprived of the little vitality it naturally possesses, and in this way it may, without much alteration, become Necrosed, or, what is the same thing, it dies. Such necrosed teeth lodging in the socket act as foreign bodies, and often give rise to much irritation; in these cases they are always better removed at once. Sometimes a tooth is only partially affected with necrosis; a part of it is deprived of its vital supply and dies. Here the irritation set up by the presence of a par-

tially dead tooth may not be so great; but the gum is very apt to be absorbed, the alveolus to become filled up, and the tooth to be extruded from its socket. Necrosis in many, although not in all, cases, may be detected by the uniform, dark, somewhat horny appearance generally assumed by teeth so affected. If such teeth excite no irritation, and are in any way useful, they need not be extracted; but if any irritation is set up by them, the only remedy is their removal.

Exostosis is a diseased condition very common among teeth, and the results of which occasion much annoyance of various kinds. The disease consists in a thickening of the substance coating the fangs, and already described as the "cement." This thickening may be general when it assumes the appearance of uniform enlargement of the root of a tooth, or it may be partial, and manifest itself in the form of nodules or projections of various kinds upon the surface of the fang. The principal evil effect produced by it is pain, and this is by no means confined to the seat of the disease, but may occur in the neighbourhood of other teeth, or in the chin, or cheeks, or even in localities still more distant

from the exciting cause. Its detection is difficult, as no reliable indications of its presence are known. As it is generally, however, in diseased teeth that it commences, some suspicion ought always to attach to such teeth where unaccountable pain occurs in their vicinity, whether they themselves may suffer from tenderness or not. Here, again, extraction is the only remedy, and will in all probability be easier to perform early in the disease, because the deposit of new cement being originated by some irritation in the tooth, continues to increase so long as any irritation lasts; and if of the nodular form, such deposit may fix the tooth more and more immovably in its socket, by each nodule making for itself a depression in the interior of the alveolar walls.

Such are the diseases by which the greatest loss of teeth is occasioned. In necrosis and exostosis, extraction, indeed, is perhaps the only remedy. In caries, the tooth may frequently be saved, provided the disease be treated early, by the cavity being filled up and protected in the manner afterwards to be described under the head of Stopping.

Alveolar abscess or gum-boil arises from the

periosteum lining the alveolus becoming inflamed, and suppurating. The pain here is usually of an intermitting character, but of a nature very well marked in its kind, and producing considerable constitutional disturbance. The matter makes its way through the alveolar wall, and lodges beneath the gum, forming the swelling characteristic of this disease. Among other causes, the irritation set up by decayed teeth is a prolific source of such affection. Warm fomentations, and opening the abscess, may here act as a palliative remedy, but the proper measure is extraction, as, by continuous irritation, such cases are apt to lead to sinus opening on the cheek, &c. After extraction, in cases of this nature, very considerable pain sometimes persists for an hour or two, owing to the irritation existing in the alveolar cavity implicated.

Another affection, also in most cases demanding extraction, is where Fungus of the pulp occurs, and appears as a red pouting mass protruding from the orifice, or projecting into the bottom of deep and large cavities in teeth where caries has been of long standing. Touching the mass with nitrate of silver may occa-

sionally lead to its disappearance, but removal of the tooth is here also the more certain cure.

The jaws themselves are liable to certain affections which it might be well very shortly to glance at here. Necrosis, or death of a portion of the substance of the jaw, frequently occurs, and generally as an extension of the inflammatory process from contiguous parts. Its progress is characterised by intense pain, great swelling of the cheek and face, loosening of the teeth, and much constitutional disturbance. It may originate in cold, blows, or previous exhausting diseases. Before the substance of the bone is attacked, however, its covering, viz., the periosteum, generally suffers. Periostitic inflammation may be considered as the early stage of the more formidable affection, and that at which treatment is easier and more effectual. This consists in hot fomentations to the part, by warm water being held in the mouth, and if great pain exist, a poultice to the cheek may be grateful, but if continued it is apt to favour the pointing and bursting of any collection of matter there, instead of within the mouth as would be desirable. In the event of matter

being already present, incisions must be made for its evacuation; and should a portion of the jaw be found bare on probing the wound thus made, an exfoliation or necrosis of a part of it may be expected. This, however, does not invariably occur even where the bone seems to be distinctly felt bare; but when it does so happen, the removal of the necrosed portion ought to be effected as soon as circumstances will permit. In such cases as those where a collection of matter opens externally, there remains a fistulous opening, which resists all treatment until the exfoliated bone, or, it may be, an offending tooth, be removed. After that, it generally closes within a period of at most a few months, and sometimes much sooner. Necrosis is an affection much more frequent in the lower than in the upper jaw.

Caries of the jaw may result as a consequence of ulcerative lesions of the adjoining parts, but perhaps never commences as a primary disease. Its most common situation is the palatal aspect of the upper jaw, where it is sometimes found following syphilitic ulceration, more especially after the use of mercury. The discussion of such lesions, however, falls more properly to the

province of general surgery, and need not be more than mentioned in the present work.

In addition to what has been said of dental disease—more particularly as limited to the teeth themselves—it may not be inexpedient here to draw attention to the influence such affections exercise on the general health. In this manner dental diseases may be viewed in the twofold aspect of a cause and an effect of not a few disorders partaking more of a constitutional than a local character. Various morbid conditions of the system—tuberculosis, diabetes syphilis, insanity, purpura, and even pregnancy itself—have already been alluded to as exercising their own peculiar influence in the excitement of various dental affections. We find the incisors suffering from lateral decay in phthisis—dental caries a general accompaniment of diabetes—the teeth notched and nodulated in syphilis—their rabbit-mouth arrangement in the insane—their loosened condition in purpura—and toothache proverbially common in pregnancy. But while these different states of the body act in this way on the teeth, these organs in a diseased condition re-act, on the other hand,

in a manner almost equally well marked on the general health (24, 29).

It by no means follows that pain, or much local uneasiness of any kind, should be a necessary condition of such a state of the mouth as entails the consequences under consideration. Indeed, it is this very fact which leads to the local cause of the mischief being so much overlooked. Patients themselves are unaware of its existence in many cases; so long as local uneasiness is absent, they will state that there is nothing to complain of in the mouth; they suspect no connection between their ailments and the condition of their teeth; they are sensible of nothing being specially wrong with these organs; they admit the long continued presence of dental decay, and an unsound state of the gums and buccal cavity generally, but they never associate these with the constitutional effects produced; the real cause, obvious as it is, consequently remains unsuspected, or is forgotten; and if the patient in this way overlooks it, there is nothing wonderful in its not being detected by the medical attendant. But it must be borne in mind, that, however obscure, a powerful and a double agency is here at work

in the production of disease. There is the assimilation of a poison, and there is the irritation produced, as already noticed, by the presence of decayed or dead stumps in the jaw. The latter mode of action is more generally conceded than the former; but any one who has seen much of dental or gingival diseases will not readily believe that the intensely fœtid pus secreted in such cases is innocuous. Nor, while its quality is sufficiently revolting, is its quantity so small as might be supposed. We must bear in mind that the pus here secreted is carried off by the saliva almost as soon as it is discharged upon the surface of the gums, and thus its appearance in very large quantity is prevented. But those who are in the habit of extracting stumps in such conditions of the mouth, know how often the blades of the forceps employed, appear after the operation as if they had been dipped in cream or some such substance; and that this fœtid pus may act, and does act as a poison, will be abundantly evident if a little care be bestowed in the investigation of such cases.

It may be argued, no doubt, that in the mouths of persons who otherwise enjoy excellent health, stumps and decayed teeth frequently

exist, and that therefore they are not to be considered as a cause of disease. Of course, in reply to this objection, it can only be stated that every acknowledged cause of disease may, if such reasoning is of any force, be discredited. We know that individuals do exist, in the enjoyment of robust health, in the midst of circumstances recognised on all hands as the fertile sources and promoters of disease, yet we do not on such grounds lay aside sanitary measures as irrational or uncalled for. The evidence in cases of the kind cannot be adduced with all the exactness and certitude of mathematical demonstration; but where analogy, and the results of experience and observation in a certain number of instances, lead to the conclusion that injurious consequences are in the circumstances possible, if not probable, we should attempt to avert them if the means seem at our disposal.

CHAPTER VI.

EXTRACTION, AND THE INSTRUMENTS EMPLOYED.

THE principal points to be attended to in Extraction are the proper seizure of the tooth, and its detachment from the walls of its socket in that direction where least resistance is likely to be met.

In seizing a tooth, whatever instrument be employed, the part upon which a hold is taken must be of sufficient strength to withstand the force necessary for dislodging the fangs. In order to obtain such a sufficiently strong portion of a decayed tooth, a part beyond the decay must be sought for. As the decay, however, frequently extends so deeply that it encroaches on those parts lying deeper than the neck of the tooth—as where the whole crown is entirely gone and a deep cavity still exists in the remains of the tooth left in the gum—the part to be grasped by an instrument will lie beneath the

margin of the gum, or even that of the alveolus. The instrument must consequently be thrust, and be of a shape to be thrust with considerable force within these structures, until it reaches a firm and sound part of the tooth, and there be made to grasp it securely, but cautiously. In reaching this part some difficulty will occasionally be met with. Where the decay has advanced on one side,—or it may be on more than one side,—below the level of the alveolus, the instrument, instead of fixing itself beyond the decayed cavity, will be very apt to slip into it, and thereby break down the remains of the tooth. And again, when the alveolus is of dense and hard consistence, or where its walls are very thick, as is often the case in the neighbourhood of the lower wisdom-teeth, it often becomes a matter of great difficulty to insert an instrument between the surface of the fangs and the socket enclosing them. Where the walls, again, are thin but dense, and firmly attached to the fangs, they are, on the other hand, apt to be seized along with the tooth, and to increase the difficulty of its removal.

The detachment of a tooth from the alveolar walls surrounding it should, as has been already

said, be made in that direction where least resistance may be expected. A tooth cannot always be drawn perpendicularly from its socket. Except in occasional instances of single-fanged teeth, the roots converge or diverge, or are bent in such a manner that they would be broken across before they could be removed by a straight pull. Moreover, even when the fangs are single, and not at all bent or distorted in any way, the firmness of their attachment is so great, that the amount of force which would be required to dislodge them by a straight pull would be more than could generally be applied by the hand, and would be unnecessarily severe for the patient, as it would be injuriously diffused over parts at a distance from the tooth to be removed. It is, of course, impossible to tell beforehand what direction or what irregularity the fangs of a tooth may possibly assume, so that, instead of attempting to take such minor details into consideration, it will be found more expedient to take advantage of some general characters which may be said to be universally present in the conformation of the teeth and their containing alveoli, and to conduct their extraction accordingly.

The fangs of all the teeth are, as has been previously described, a little broader at their external than at their internal edge or border, consequently they may be moved outwards much easier than inwards. Again, the external wall of the alveoli is much thinner and weaker than it is internally, consequently the external wall yields much more readily than the internal one. And, coupling these two facts, it will be seen that a tooth will be much easier dislodged by a force applied in an outward and downward, or in an outward and upward, direction in the upper or lower jaw respectively, than by any other mode. There is, however, an exception to this rule, and that is in the case of the lower wisdom-teeth ; the external plate of the alveolus being in their case very much increased in thickness by the strong ridge passing down from the coronoid process of the lower jaw. As these teeth, however, are comparatively small and not generally very firm, this disadvantage is so far counterbalanced.

Keeping these facts in remembrance, the extraction of any tooth becomes much simplified, and the form of instrument most suitable for the particular case can easily be selected. Where

all or most of the crown of a tooth remains intact, extraction ought to be performed with Forceps. The blades of such forceps must be adapted to the particular tooth in two ways,—first, they must be so bent as to reach it easily; second, their edges must be so shaped as to be easily inserted within the alveolus. No one pair of forceps can possibly be thus adapted for all teeth,—the great variety in size, form, and situation of the different teeth rendering this impossible; and although all teeth *can* perhaps be got out with a bone-pliers, or even with a common brad-awl,—a mode in which the resurrectionists used to practise with profit and success,—yet such methods of extraction are necessarily severe and imperfect. Five pairs of forceps will be found serviceable for most purposes, and fewer will not. These are a straight pair, and a pair with the blades nearly at right angles with the handles, both of which will be required for upper and lower roots and single-fanged teeth; a pair adapted for the lower molars, and two pairs for the upper molars—one for the right and one for the left sides. Many other forms would be desirable, and may be collected, but these five pairs will be found abso-

lutely necessary. It has been stated that the blades at their extremities should fit that part of the tooth they are intended to grasp. In this way, it will be seen, that for single-fanged teeth these blades will merely require to be adapted for the oval form presented by a transverse section of such fangs—hollowed out, in fact, so as to apply themselves more closely to their surface. For multiple-fanged teeth, the forceps must also be, on the same principle, adapted to the form of the surface to which they are to be applied. One pair will be found to answer for the double-fanged molars of the lower jaw, but for the three-fanged molars of the upper jaw two pairs will be necessary, as these three fangs are always so placed that two of them are next the cheek and one towards the palate; consequently the forceps which would fit one side will not at all fit the other. With this number of forceps properly constructed, almost any case of extraction may be undertaken where forceps can be used at all.

But there are cases where forceps are unserviceable. In many instances where stumps are causing irritation, or require removal, they are so far decayed as to be altogether beyond the

reach, or too friable to admit of the use, of any grasping instrument. In such cases recourse must be had to what is termed the Lever, Elevator, or Tooth-punch. This most useful instrument exists under a variety of modifications, but in all its principle consists in an instrument terminating in a strong spoon-shaped or sometimes spear-shaped blade, from a quarter to fully half an inch long, intended to be thrust down between the stump and its containing socket, wherever a proper purchase or fulcrum can be obtained, and by which, in the manner of a lever, the remains of the tooth can be extended from the alveolus. One or more of these instruments ought always to be at hand in every case of tooth extraction; and their mode of use is so simple, that to attempt describing the infinite variety of modifications which may be followed in their application is unnecessary. The chief point to be attended to is, that such instruments be not allowed to slip, as considerable injury might thus be done to the cheeks, tongue, or other structures within the mouth.

Another instrument, formerly much more employed in tooth extraction than it is now, is the Key. This instrument, from the immense power

possessed by it, is liable to abuse in its application. Its form is too well known by all who are likely to be interested in these remarks, for any description of it to be here required. Suffice it to say, that when judiciously handled and restricted to such cases as really demand its use, the key is of very great service indeed, and to discard its employment altogether, would be relinquishing an instrument which, in certain cases, no other could replace for simplicity and effectiveness. The cases in which the key is principally useful are those where the forceps incline to break down the remainder of a tooth without obtaining a sufficient hold for its removal, and where, on the other hand, the elevator would be applied at a great disadvantage for want of sufficient purchase. Such a case may be exemplified by the circumstances of the remains of a molar tooth upper or under, requiring removal, while as yet not only firmly impacted in the jaw, but tightly jammed between the adjoining sound teeth, especially where the decay has been extensive and deep on one or other side of the neck of the tooth, leaving the outer or inner wall tolerably sound. In such a case, by fixing the claw on the sound side of the tooth,

and turning it out in the opposite direction, it will in most instances be removed more easily and expeditiously by the tooth-key than by any other instrument whatever.

By attention to such matters—to the form of the tooth—to the part where it is seized—to the direction in which it is moved—and to the construction of the instrument employed—tooth extraction becomes very simple. Any hurry is inexpedient in the operation; the eye and the hand should have sufficient time to enable the operation to proceed according to what is observed or felt; and it may be laid down, that whenever the tooth is felt to be started from its attachments, be it ever so little, all the severity of the operation is over. The position of the hand in grasping a forceps has been sometimes made the subject of discussion. This, however, is a matter of habit, varying with the height, the posture, the wrist strength, &c., of the operator. It may be stated generally that two different styles of applying the force necessary for extraction—explain all such varieties in operating—namely, that where the force is applied by pronation or supination of the fore-arm, and that where it is applied from the shoulder

joint. Keeping in view, then, these general principles, their application in the extraction of each individual tooth will vary to a certain extent, but will be easily understood if the anatomical peculiarities of the tooth to be operated on be borne in mind.

The incisors of the upper and lower jaws are seldom extracted before these teeth are either loose or reduced by caries to a condition little better than that of stumps. This latter condition is much more common in the upper than in the lower jaw; as the inferior incisors are in far the greater number of instances lost by becoming merely loosened and extruded from the socket. In extracting the upper incisors by means of forceps, the round and conical fang permits of their being rotated at the time of their being also pulled downwards and slightly outwards from the alveolar cavity; but in the lower incisors, the movement for their extraction must be confined to that of bending them steadily outwards, or rather forwards, at the same time that they are forcibly raised from their socket; as from the flattened form of the fang, any attempt at rotation here would lead to the tooth being broken. Sometimes, how-

ever, as from advanced caries in the upper, or from great crowding among the lower incisors, the forceps cannot be employed. In these circumstances, recourse must be had to the elevator. The mode of using this instrument for the removal of single fangs of any description is much the same; the principal variations in its application arising from the difficulty of access to some situations in the mouth. For removing the fangs of the upper incisors a straight-pointed elevator should be employed. It should be inserted nearly parallel with the long axis of the tooth, with its flat or hollow side next the stump to be removed; and with considerable force, and by a semi-rotatory boring motion, be made to insinuate itself deeply alongside it, between it and the adjoining root or tooth. The instrument will then probably have obtained a hold or bite upon the stump, which should now, by making the handle of the elevator describe part of a circle, be prised upwards and downwards from its socket. If, after it has been started by the elevator, the fang still adhere to the adjoining tissues, it can be easily lifted away by a pair of straight and slender pointed forceps. The lower incisors have

been mentioned as sometimes requiring the elevator to be employed, on account of crowding rendering the application of forceps impracticable. Here the same form of elevator may be used in another method. Instead of inserting it down the alveolus, so as to make it lie parallel with and alongside the fang, it may be inserted diagonally across between the tooth to be removed and the adjoining one. The hollow or flat side of the instrument must be kept next the offending stump or tooth, and, in this position, driven somewhat downwards between it and that adjoining, until a hold can be obtained on the side of the fang to be extracted, when, by now rotating the handle of the instrument on its long axis, the tooth will be forced upwards and outwards from its socket. In other cases the same steps may be followed as in removing upper stumps.

The canine teeth of both the upper and lower jaw offer great resistance in their extraction. This is best overcome by using a strong but narrow-bladed straight forceps; inserting their points forcibly and deeply within the margin of the alveolus until a firm and somewhat extensive grasp of the fang has been obtained; and then, with a steady and powerful movement principally

outwards and downwards in the upper, and outwards and upwards in the lower, the attachments of the fang will be found to yield, when it can with but little force be lifted from the socket. The employment of the elevator is sometimes required for the removal of these teeth. But except the greater amount of force here necessary, the instrument and its mode of use is the same as has been described in reference to the removal of the incisors. There is one condition, however in which chiefly the upper canines are occasionally met with where the proceedings for their extraction require to be somewhat modified; that is, when these teeth are found so displaced as to lie externally to and above those adjoining. The extent of this displacement varies considerably, but in many cases it is so great that, owing to the inconvenience and deformity occasioned, remedial measures of some kind very soon become indispensable. These, in many cases, are limited to extraction of the displaced canines themselves; and this is to be effected, in a large proportion of instances, only by the elevator. Little more than the apex of the tooth may be found well through the gum, while the position and form of the fang is indicated by a projection

of the tissues covering it. In these circumstances, it becomes impossible for a sufficient hold being obtained by forceps for the tooth's removal. The best mode of procedure, here, is to make a slight incision upwards—along each side of the crown of the tooth; then, by inserting the point of the elevator at right angles to and beneath the fang, it can be used as a lever to loosen and detach the tooth by lifting it, as it were, with an outward and downward movement, when, from the less complete fixation at this early period of development, it will be found to yield very easily.

The upper bicuspids are in general more firmly fixed than those in the lower jaw. This, coupled with the fact of their fang being commonly much compressed from side to side, and occasionally divided into two slender rootlets, renders them more liable to fracture than the lower bicuspids. The laterally compressed fang of the upper bicuspids renders it injudicious to attempt anything like rotation in their removal; they should be grasped deeply in the socket with a straight-beaked forceps, and steadily moved outwards until they are found to yield, and then, with a straight pull downwards, not

with any sudden jerk, however, their extraction may be completed. The fang of the lower bicuspids, again, is long, round, and tapering. They would, therefore, admit of rotation in their removal, but this is less easy from the upper teeth interfering with the necessary position in which an instrument would require to be applied for this purpose. These teeth are therefore best extracted by using a forceps with long and slender beaks, bent at right angles, or nearly so, to the handles. The beaks should be deeply sunk on the labial and lingual sides of the fang, when, partly by rotating the tooth—partly by moving it slightly outwards and inwards, it will generally start upwards between the blades of the forceps without further trouble. Sometimes the stumps of bicuspids, both upper and lower require the elevator to be used for their removal; but the principles upon which this is to be done are the same as those for such single-fanged teeth as the incisors and canines, already alluded to.

The molars of the upper and lower jaws differ from each other, as has been already described, in one important point, so far as their extraction is concerned, and that is, in the upper molars

possessing, besides an interior and posterior fang, another single fang directed towards the palate. In this way the upper molars require a separate forceps for the teeth of either side; whereas one forceps answers for extracting the lower molars of both sides. The molar teeth, both above and below, especially the anterior molars, require great force for their dislodgment. In this manner a very firm grasp has to be made upon them, and, should caries be advanced to any extent, fracture is thus extremely liable to occur in their extraction. This accident is to be obviated by attaining a hold upon the tooth at as sound a part of it as can be reached. The points of the forceps blades should be thrust deeply towards the alveolus, so as to lay hold on the fangs—not the neck or crown of the tooth—and then, with a force chiefly directed outwards, the tooth, whether above or below, is to be detached from its connections with the socket. The third molars or wisdom-teeth frequently present characters so exceptional, however, as to render some modification of this rule necessary. These teeth are often found directed outwards or inwards, or forwards or backwards, and in such

circumstances their extraction demands a corresponding adaptation on the part of the operator. This, however, can only be, in each individual case, decided on by his own judgment and skill, the general principles of procedure remaining the same. In many cases the key is of invaluable service in removal of the molar teeth; and it is very questionable whether its judicious use causes any greater suffering to the patient; the probability being that it enables the operation to be performed with much less instead of causing increased pain in a number of instances. The cases where this instrument is of greatest service are those where the labial or lingual side of the tooth has been entirely destroyed by decay; those, again, where the crown is gone, and where the fangs are so jammed between the adjoining teeth as to render the elevator less applicable; and those where this instrument and the forceps have both failed from any other cause to effect the tooth's extraction. The principal points to be attended to in applying the key are—to have a tolerably sound spot, however small, on either the lingual or labial side of the tooth where the claw can be fixed; to have the bolster or fulcrum steadied, so that it will not

slip out of its proper position; and never to apply more force than what ought to dislodge an average tooth. If these directions are followed in conformity with what has been previously laid down respecting this instrument, it will often be found of much use where the forceps or elevators have been unsuccessful. After a molar tooth has been loosened in its socket, there is occasionally some difficulty still existing in completing its removal; and this frequently arises from one of two causes. First, in the anterior molars the fangs are often so divergent as to prevent their passing through that part of the socket originally embracing the neck of the tooth, or even to clear the space left between those teeth immediately adjoining the one attempted to be removed. And second, in those cases where the crown of a molar tooth has been long decayed to a level with the gum, the adjoining teeth tend to bend and close over the remains of the deceased molar, and to render its extraction liable to be accompanied by loosening or even complete dislodgment of one of its neighbours, especially of the second bicuspid, where this tooth is involved in such circumstances. Where such merely physical difficulties, how-

ever, present themselves, in the extraction of these teeth, there is obviously nothing except a watchful eye, and a ready hand, on the part of the operator, accompanied with a familiar knowledge of the anatomical form and relations of the teeth themselves, that can be laid down as of universal application for overcoming these obstacles.

Sometimes, after the removal of a tooth, unusually protracted or excessive bleeding may occur from the alveolar vessels. In certain cases—and these are the most to be dreaded—this arises from abnormal quantity or defective quality of those constituents of the blood necessary for what is termed its coagulation. The occurrence of hæmorrhage is usually a constitutional affection, and arising either from an acquired condition of the blood, as in scorbutus, or from a natural defect in its composition, as in the ordinary hæmorrhagic diathesis. This affection, in its peculiar character of superabundant white corpuscles, was first described by Professor Bennett of Edinburgh; and since that additional light has been thrown on it by Virchow, Remak, Vogel, Weber, Rokitansky, Kölliker, Jenner, Parkes, Piorry, Gulliver, Bichat, and

others. Other morbid conditions almost always coexist with it, and among these enlargement of the spleen is perhaps the most common. It is sometimes observed also, as noticed by Holmes, that accidental circumstances may induce the hæmorrhagic diathesis in young and healthy persons, such as deficient light or food, damp and unhealthy localities, &c. And although, as has been remarked, it is often congenital, it may also appear only in adult life, and may from that time be persistent. Hæmorrhage, too, itself becomes a cause of this diathesis, by reducing the density of the blood. Cases of this kind require medical treatment of a constitutional nature, in addition to local measures for arresting the flow of blood; but the directions for such treatment scarcely fall within the province of a work on Dental Surgery (33). Where the cause is purely local, however, the treatment will be local also, and may be briefly summed up as consisting of pressure accurately applied and retained for twelve or twenty-four hours in contact with the bleeding surface. The best mode of applying such pressure is by means of a very narrow strip of lint firmly packed into the socket of the tooth until it is completely

filled—care being taken that all clots, loose stumps, &c., have been previously cleared away. Should it be desired, any of the usual styptic or astringent applications may be employed along with such pressure. Of these, perhaps the most effectual is the saturated solution of perchloride of iron in glycerine. The lint may be soaked in this solution previously to its being employed as a plug; but there is little doubt that whatever accessories may be had recourse to, pressure, accurately and continuously applied, is here the most reliable measure for the suppression of hæmorrhage. After plugging the alveolus in this manner, a firm pledget of folded lint should be placed above it, so as to be retained in its place by the teeth of the opposing jaw—upper or lower as the case may be. This serves to increase the pressure on the bleeding point; but what seems to be of still more service, and what has been somewhat overlooked—if of proper size, it keeps the jaws somewhat separate, and thus prevents the involuntary tendency to sucking the part from being so apt to take place—a circumstance exercising much influence in these cases.

CHAPTER VII.

FILLING OR STOPPING TEETH—THE MATERIALS EMPLOYED, AND THEIR MODES OF USE.

FILLING or stopping a tooth affected by caries is an operation requiring care in many ways, and attended with considerable difficulty in its performance. A tooth selected for filling should not be too far advanced in decay. The intention of the operation properly is to save what remains of a tooth, rather than to restore it to its original bulk. What is essential is to fill up the cavity left by an attack of caries, and so to cover up and protect the exposed but otherwise sound dentine into which such cavity has opened. If this cavity have extended completely through the dentine, so as to reach the sensitive pulp in the centre of the tooth, the operation becomes more complicated, and the chances of success greatly diminished. If the crown of the tooth be nearly all gone, and what remains be occasioning suffering, or where the

tooth is loose, or where the root or socket is inflamed, or where gum-boil has existed in connection with the tooth, stopping, as a general rule, should not be attempted. Exceptional cases do now and then occur, but teeth, in such conditions as those described, do not fall within the scope of this operation. Its legitimate object is strictly that of merely plugging up a cavity penetrating the dentine where the disease is limited to this lesion. And if patients allow the disease to proceed, or if it be overlooked in any way until total or almost total demolition of the crown of a tooth be accomplished, then extraction, and not stopping, is the proper remedy.

The first step in stopping or filling a tooth is to get ready access to the cavity, so as, if possible, to see into it. In order to do so, the patient must be placed in a position that will most accommodate the operator. If the cavity exist between the adjoining sides of front teeth, they had better be separated by stretching a small, flat strip of India-rubber, and inserting it between them, so that, on contracting by its own elasticity, it will either at once, or in some hours afterwards, separate the teeth. If the

cavity exist between the molar or bicuspid teeth, their adjacent sides should for a like purpose be cut away to a certain extent by an enamel-cutter or a file.

The second step is to clear out the cavity, and to shape it so that the stopping may be securely retained. A large amount of softened dentine will generally be found lining the cavity in a carious tooth; this must be cleared away by means of the small hoe-shaped instruments termed Excavators, until the sound, firm, normal dentine is reached. The enamel edges forming the mouth of the cavity should be reduced to a regular form, so that no rough, overhanging, or projecting portions may be left. And if not perfectly cylindrical, the cavity itself, so cleared out and prepared, ought to be as nearly so as possible, and, if anything, rather larger within than at the orifice.

In many cases, however, it would be disadvantageous, even if it were possible, to obtain a cavity of this kind. The decay is often shallow, although somewhat extensive superficially. In other cases, one part of it may be deep, while the rest diminishes in extent, and approaches the surface by a gradual incline; a form of

cavity frequently found on the sides of the upper front teeth, where it exists as a deep excavation at the neck of the tooth, and gradually diminishes as it comes to the surface and approaches the cutting edge, until it forms a mere chink or fissure in the enamel. In these cases, the edges of the cavity should be well counter-sunk, or what are termed retaining points may be cut, in order to fix the stopping in its place; these consist of little hollows or pits drilled in various directions into the dentine forming the walls and floor of the cavity, so that the stopping, being inserted into such pits, is more securely fixed than if it merely had the unbroken interior surface of the cavity to depend upon. After clearing out and shaping this cavity, a small pellet of cotton wool dipped in carbolic acid may be used to swab out its interior—the antiseptic properties of this agent rendering its use of much service in such cases.

The third step is to fill the cavity. This must be done with some material which will withstand the effects of such decomposing influences as it may be subjected to in the mouth, and the usage to which it is liable in mastication. The most common substances employed are different

preparations of Gutta percha, various Amalgams, and Gold or Tin foil. Several materials are also employed as temporary stoppings, where a tooth is so tender as to render it advisable to delay filling it permanently, These are such substances as cotton wool, dipped in a solution of mastic, or of gutta percha in chloroform, or a thick solution of either of these, formed into a paste with chalk, tannin, or such like, and which, by renewal from time to time, may serve to protect a carious cavity from the air until its sensitiveness becomes diminished.

Among permanent stoppings, the amalgams usually employed are those of various proportions of tin and silver, formed into a paste with mercury. Palladium, cadmium, and even gold, have been added to such amalgams, but the advantages thus derived, if any, have been very trifling, and for all ordinary purposes an amalgam of silver, tin, and mercury, will be found as good as any other, where this form of stopping is applicable. The tin and silver should be melted together, and run into an ingot; it can then be reduced to filings of sufficient fineness to mix easily with the mercury when required. Another kind of stopping, useful

where metal might be conspicuous, is what is termed osteo-plastic stopping, and consists mainly of oxide of zinc mixed with a saturated solution of chloride of zinc. This soon sets, and becomes a hard and white stopping of considerable durability.

Where gold foil is used as a stopping, it should be quite pure, and so thick, that a leaf of it, about four inches square, should weigh from three to six or seven grains. Tin foil may be used a little thicker.

When the cavity is prepared, as already described, it should be filled up with some cotton wool, to prevent the entrance of foreign substances previous to introducing the stopping; and immediately before the process of filling is commenced, the cavity should be thoroughly dried, and kept as dry as possible during the process. If gutta percha stopping is the material employed, a pellet of sufficient size is to be heated over a small flame—not in hot water—until it is as soft as it will become without burning; and if the tooth can bear it, the plug should be inserted in this state, and packed into every crevice, care being taken that especially the orifice of the cavity should be her-

metically sealed up by it. The instruments necessary for this process are few and simple, and they answer equally well for amalgam fillings. They are what are termed Pluggers, and consist of instruments about six inches long, having a steel shaft fixed in a handle of wood or ivory, and sometimes the shaft itself so formed as to dispense with this construction. The shaft terminates in a blunt rounded point, bent nearly at a right angle, about half an inch from the end of the instrument, so that the extremity may be easily inserted into the cavities in molar teeth, &c. Three sizes of these instruments will be sufficient, of the respective diameters at the point of one, two, and three-sixteenths of an inch.

Where amalgam is used nearly the same proceedings are required as in the working of gutta percha fillings, with the exception that the amalgam is plastic at ordinary temperatures. The metal filings and the mercury should be rubbed up together in a small mortar, and afterwards kneaded in the palm of the hand by the finger and thumb, until all the superfluous mercury is squeezed out. The cavity should then be lined with the amalgam, more and more

of which should be added until the stopping is complete. Neither in gutta percha nor amalgam stoppings should any superfluous quantity be left about the tooth, nor should any part of the stopping be allowed to press on the gum or adjoining parts. In using osteo-plastic stopping, both the cavity and the plug must be kept quite free from contact with the saliva during and for four or five minutes after inserting the plug, which, when set, may be dressed down to the level of the tooth's surface or otherwise as may be desired. The introduction of this stopping is proceeded with in much the same manner as that of amalgam.

Filling with gold or tin foil is a much more difficult process than any of those described. No mere description of the various modes of operating will ever enable any one to become expert at its performance without actual practice. The principles upon which this method of stopping is conducted are, that the first portions of foil introduced being accurately adjusted by pressure to the floor and walls of the cavity, and each successive portion, as it is added, being consolidated against the preceding ones, the whole being, if possible, so

arranged that the edges and not the sides of the layers of foil shall appear on the surface of the plug, an all but solid mass of metal shall exist within the cavity on the operation being finished.

The instruments employed are in their general form somewhat like those for amalgam stopping, but instead of rounded or blunt-pointed extremities, the pluggers used for foil-stopping are chisel or wedge shaped, and sometimes serrated at the edge. Various sizes and curves of such instruments are required to enable them most easily to enter any cavity according to its situation. The foil to be introduced may be lightly rolled into little soft pellets, or into short cylinders, or a strip may be folded and twisted into the form of a loose rope, or, in short, fashioned in whatever form may be found to pack with most security and solidity, according to the nature of the cavity and circumstances of the case.

Perhaps the best mode is that where all the foil introduced shall be in one continuous piece, such as in the method where the rope form is selected. One end of such rope is to be introduced and applied against one side of the

cavity; and by doubling the rope upon itself, portion after portion of it is introduced in a zigzag manner, until it is quite full. The remainder which may project beyond the cavity being forcibly compressed and burnished down to the level of the tooth's surface, the operation is completed. Whatever method be adopted, the cavity must in one way or other be packed quite full, the object in all cases of stopping being to produce a plug that shall completely fill the cavity, resist chemical action, withstand the tear and wear of mastication, and be impervious to fluids.

Where teeth are so sensitive that stopping cannot be performed, it sometimes becomes necessary to destroy the pulp entirely. This, in straight single-fanged teeth, may be done by boring it out, by inserting a slender, square-sided, pointed instrument, termed a broach, into the fang, and rotating it once or twice. Where more than one fang exists, this cannot be done, and in these cases some escharotic, such as chloride of zinc, or, what is better, common white arsenic in very minute quantity, may be introduced into the cavity, and retained there by a temporary filling of wax or gutta percha

for some hours, when it should be removed, and next day the excavation and stopping may be proceeded with.

Sometimes, after stopping with any metallic substance, heat or cold more readily produces uneasiness, owing to the better conducting powers of such metal. Here some other stopping may be tried, as, for example, gutta percha. But should such symptoms continue, extraction will most probably be required in the end. Occasionally, also, a stopped tooth may become the cause of insufferable pain, owing to some discharge of matter from its carious surface being pent up by the stopping. In such a case, the stopping may be removed, or a hole drilled into the pulp beyond the cavity which has been stopped; but as this is almost reducing the tooth to its former condition, for which the stopping was performed, extraction is perhaps the more rational treatment.

CHAPTER VIII.

ON CHLOROFORM, AND OTHER ANÆSTHETICS IN DENTAL SURGERY.

Considerable attention has been directed towards discovering or elucidating those methods by which pain, during the performance of the little operations required in dental surgery, might best be diminished or altogether avoided; many of the experiments, with such a view, have been conducted with much assiduity and not a little expense; and there is no doubt that some credit is due to those who have, even by the failure of their proposed methods, contributed to our knowledge on the matter. The means adopted have generally been of two kinds, namely, 1*st*, The induction of a state of general anæsthesia; and, 2*d*, The induction of insensibility at that part only where pain is to be inflicted.

Perhaps in no other operations have the circumstances of the case to be more taken into account in the induction of anæsthesia, whether

local or general, than in those performed within the cavity of the mouth. The locality itself, the severity of the pain inflicted, and, at the same time, its short duration in dental operations, and the complications attendant on the interference, here sometimes unavoidable, with the function of respiration or even deglutition —are circumstances which present themselves for consideration, as specially attaching to this department of surgery, and sometimes entailing extra risks to what are inherent to the employment of anæsthetic agents in other cases, where the operations are in a different and more accessible quarter; and it is mainly owing to these facts that so much difficulty and so much variety of opinion exists with reference to the employment of such obtunding agents in the practice of dental surgery.

For a long time back it has been an object with dental practitioners, to discover, if possible, some mode by which *local* insensibility to pain during tooth extraction might be obtained; no generally applicable or effective means of this kind having as yet been realised, although the investigations and experiments made with this object have been numerous and, in many instances, well con-

ducted. For how long a period the idea has been entertained that tooth extraction might be performed without pain, it is difficult precisely to determine; nor is it easier to enumerate all the different modes which have been adopted with such an intention in view; but we know that for similar operations *local anæsthesia* was mentioned by the ancients, as by Dioscorides, and described as a possible if not an ordinary mode of practice among surgeons and others; and it has long been popularly asserted, too, that the Chinese have for some unknown period been, and are now, the possessors of a secret method of extracting teeth without pain or suffering of any kind. Various statements exist in reference to what their method consists in; it has been described as a process by which insensibility of the part results from the application to it of some substance of a benumbing or powerfully anodyne nature—but what this substance is, if it exist, appears to be involved in mystery. On the Continent, too, and sometimes in England, every one is aware of the manner in which the well-known mountebank practitioner has puffed his wares, and set off the painless nature of his operations—especially tooth-drawing; and how

implicitly his "Clientelle" seem to embrace his confident assertions, rather than give way even to the testimony of their own sensations.

1*st*. Regarding the local application of Anæsthetic Substances, more properly so called. Little need be said of the attempts to induce local insensibility by mere external application of these agents, since, as yet, it has failed to produce effects anything like sufficient to enable a tooth to be extracted without pain. Chloroform, ether, opium, aconite, amylene, bi-sulphuret of carbon, cyanide of potassium, hydrocyanic acid, &c., have all been tried in this way, and the result has been to prove them, when merely applied to the unbroken surface, as entirely ineffectual for such purposes.

2*d*. Congelation of the parts by the application of freezing mixtures has been suggested for the induction of local insensibility during tooth-extraction, and other operations in dental surgery. This mode of inducing local anæsthesia, although by no means new, was some time back revived, and several ingenious enough contrivances were brought forward with the view of facilitating the employment of this agency, and rendering it serviceable in dental opera-

tions; as yet its application, however, has been by no means easily managed, nor at all certain in its effects, even if it could be said to be without danger in those cases where insensibility might happen to be produced. There is no doubt that where a part is frozen hard, insensibility is lost. But to produce this effect satisfactorily is much easier in theory than when it comes to be put into practice. Within the cavity of the mouth, as has been already observed, several difficulties have here to be contended with: 1*st*, There is the difficulty of producing sufficiently deep and extensive congelation, except in some easily accessible quarter of that cavity; 2*d*, There is the uncertainty of pain being avoided after all, no matter what apparatus be used—as, even supposing the part has been fully frozen, the slightest delay or accident during the operation entirely frustrates our object here; and, 3*d*, There is no doubt that unpleasant results may at any time be the consequence of such an injury being inflicted on a part which is frozen, as that entailed in the extraction of a tooth. The pain produced by the freezing process itself, too, is in many cases worse than that of extraction.

Of all forms of freezing apparatus that upon the spray-producing principle is the one in every way the most serviceable, the congelation being effected by the contact of ether in the state of finely divided spray forcibly impinging upon the part to be frozen. The "Ether Spray Apparatus," as it is called, becomes in this manner useful in a great variety of cases, chiefly of a kind, however, where the pain of the operation is confined to the superficial tissues, such as the gum in extracting loose stumps, the surface of an excised root in filing or boring it, and, in certain cases, to the extraction of teeth from such situations in the mouth as render its effects easily and fully producible; as, for example, in extracting any of the eight anterior teeth of the upper jaw; the extraction of the corresponding lower teeth being more interfered with by the flow of warm saliva generally accompanying the employment of the spray. Various shapes in nozzles for directing the stream of ether against the part to be operated on have been constructed, but those of the most simple form will be found most useful; and, with a very little experience, this mode of inducing local insensibility is one very easily managed.

3d, Another method attempted for the production of local anæsthesia has been the application of Galvanism or Electricity. Partly, it would appear, owing to some misconception of the results observed in certain physiological experiments made on the nervous system by these agents, and partly, it may be, owing to an erroneous notion entertained in reference to the feeling experienced in a part through which the electric current is passed, the conclusion seems to have been come to by some, that electricity could be easily employed as a local anæsthetic. But the mistake here committed seems to have arisen from confounding mere *altered* with *arrested* nervous sensation, as the pain of the operation, in fact, becomes in such cases not less in amount, but different in kind—the electric thrill not supplanting, but being superadded, to such pain.

There seems, however, to be no reason for altogether despairing of ever being able to discover some mode of producing insensibility over a limited surface. We know that several anodyne remedies produce this effect *to a certain extent;* and from the relations of the teeth to the tissues covering them—no part of them being in reality

at any depth from the surface—we may, at least, hope with some confidence in their extraction being yet practicable with much amelioration, if not entire absence of pain.

In the meantime, however, no method which has been tried can ever be compared, either for facility or effectiveness, with that of inducing a state of *general* anæsthesia. And before speaking of the leading agent for this purpose in all prolonged or serious operations—chloroform—allusion must be made to a recent accession to our means of rendering dental operations painless, viz., the employment as a general anæsthetic of nitrous oxide, or what used to be called Laughing gas. The effect of this gas in producing unconsciousness has been known from a remote period in the history of modern chemistry. It was proposed, and tried, and discarded, as an anæsthetic about the end of last century, and has now been revived, and promises to answer well in rendering short operations painless. The apparatus employed in its exhibition consists of a reservoir for the gas and a face-piece communicating therewith, for applying over the mouth and nose of the patient when insensibility is wished

to be produced, by substituting this gas for the atmospheric air in respiration. In order thoroughly to effect this end, the gas must be inspired *unmixed* with air. Some recommend the gas to be thrown off as waste material at each expiration; others have advocated its being respired over and over from a bag or other reservoir until the patient become insensible. In either way, this generally occurs in from forty seconds to two minutes. The appearance of the patient, when the full effect of the gas is produced, resembles that presented in asphyxia or impending suffocation; but the lividity and other symptoms rapidly pass off on the re-admission of air to the lungs. Some patients manifest only a slight degree of such appearances, in others they assume a very marked and somewhat threatening aspect. The rapid recovery of patients from the anæsthetic effects of this gas has led to a supposition that it possesses no dangerous properties like chloroform, and may therefore be recommended as absolutely innocuous. Such, however, is not exactly the case (42). If pushed too far its fatal effect on animals would probably, in the large majority of cases, be more quickly produced than that of

chloroform. But it appears to have the advantage of acting only so long as it is applied, and leaving no accumulation of a poisonous agent in the system (39). In chloroform not only must air be admitted, but the chloroform accumulated in the circulation be got rid of before its effects disappear; whereas in nitrous oxide, on the mere admission of air to the lungs, the patient at once recovers. There seems little doubt of this being due to the fact that much, if not all, of the effects produced by nitrous oxide are closely analogous to those of suffocation. There is no impediment to the *act* of respiration, and the gas inspired is in no way unpleasant. In this manner the sense of suffocation is not felt, but the symptoms during unconsciousness almost demonstrate its large share in the operation of this agent. The investigations and experiments of chemists and physiologists show that nitrous oxide belongs to a class of substances which not only prevent oxygenation of the blood, but even displace its constituent oxygen; thus producing what might be termed an exaggerated asphyxia (39). That it possesses some influence on the nervous system apart from this is possible, and even probable; but

what is to be borne in mind is, that an agent capable of inducing so much of the phenomena of apnœa is not to be administered any more than other anæsthetics, without great caution.

Previously to commencing an operation under any anæsthetic, whether chloroform, ether, nitrous oxide, or whatever it may be, everything should be ready at hand, and resolved upon previous to the state of unconsciousness being produced, so that no time may be lost. And in using nitrous oxide, it will from its evanescence be almost necessary to depart from a rule laid down for chloroform, and place a gag of some kind between the patient's teeth previous to exhibiting the gas, in order that no delay may be incurred in opening the mouth. The full accession of insensibility is here generally indicated on the patient's not responding to such requests as to lift the hand, this being not unusually agreed on as the sign to be regarded by the operator as time to commence his proceedings. The general aspect of the patient, and unconsciousness to all stimuli, are equally plain indications of the desired condition having been attained (41). Here, however, the experience of one or two cases actually witnessed,

will convey more information than any description of them that can be written.

With reference to the injurious effects likely to result from this gas, they do not seem apt to be sudden or immediate so far as any fatal result is concerned. It is likely that in some degree it would be detrimental in cases of phthisis as well as in hæmoptysis, and in the hæmorrhagic diathesis (40). In such circumstances as those, where venous congestion might be injurious, it is difficult to say whether certain effects at a remote date might not occur from vascular distension, if the coats of the vessels were unsound at the time of inhalation. The anæsthesia being caused by deficient oxygenation of the blood, and consequent capillary stasis in the brain—and the heart's pulsations continuing after the cessation of respiration, it follows that on air being allowed to be again respired, the animal recovers—quickly regaining consciousness, sight, hearing, sensation, and muscular power (40). And from the very well marked indications afforded of its progressive effects, it is improbable that any one would push its exhibition to an extreme extent.

For operations of a protracted nature, however, and where the insensibility requires to be maintained for any length of time, chloroform, so far as our knowledge or experience of such agents yet extends, is decidedly the most desirable in every way.

The late Dr Snow of London gives an interesting *resumé*, in his work on Anæsthetics, of the history of these agents. About the close of last century, Sir Humphrey Davy instituted a number of experiments with nitrous oxide gas, as an anæsthetic; and this eminent philosopher suggested that this gas might yet "probably be used with advantage during surgical operations." The honour of first acting on this suggestion seems due to the department of dental surgery. This occurred so long ago as December 11, 1844. The operator on this memorable occasion was Dr Riggs, the patient, Mr Horace Wells, both dentists of Hartford, Connecticut. The story is well known. Nitrous oxide was supposed to be uncertain in its results; a case having occurred where it failed to prevent pain in tooth extraction, and that in presence too, be it remarked, of Dr Charles T. Jackson, professor of chemistry, and W. T. G. Morton,

surgeon-dentist of Boston. Now, besides nitrous oxide, sulphuric ether had been at that time for more than twenty years known to resemble in its effects those of nitrous oxide; and knowing this, and nitrous oxide having apparently failed, Dr Morton, on the 30th September 1846, exhibited sulphuric ether to a patient, and extracted a tooth without pain. A question now arose between Jackson and Morton (although both were associated in a patent regarding the application of ether), as to which of them had been the means of bringing its properties to light; and, in the meantime, Dr Bigelow of Boston communicated the matter of its exhibition by them in such cases to Dr Boot of London. The result was that Mr Robinson of Gower Street, administered ether and extracted a tooth painlessly to a young lady, at the house of Dr Boot, on the 19th of December 1846. On the 19th of January 1847, Professor Simpson administered it at Edinburgh in a case of labour, and ascertained that it was capable of removing the sufferings of the patient without interfering with the process of parturition. Ether was now becoming more and more widely and confidently used in general practice, when Pro-

fessor Simpson, having had his attention turned to such matters, discovered that another substance, Chloroform, possessed such advantages over ether, that he at once laid it aside and adopted and recommended the employment of chloroform in its undiluted state, as incomparably superior in every respect. The new anæsthetic was tested, and found so suitable, that to the present day it stands unrivalled.

According to some elaborate investigations made on this subject, five different degrees of narcotism seem to be producible by chloroform. The first of these includes all the effects of that agent so long as perfect consciousness remains; the second is while the mental functions are impaired, but not necessarily suspended; the third is when voluntary motions cease—this also being the stage in which rigidity of the muscles and inarticulate mutterings occur, and the *perception* or *consciousness* of pain is lost; the fourth degree is during the complete relaxation of the muscles, when the breathing is stertorous, and the patient perfectly insensible; the fifth degree is that where embarrassment or cessation of the breathing takes place; and the ultimate and greatest

effect chloroform can produce, is described as that where the irritability of the muscles is destroyed, and *post-mortem* rigidity induced. These seem certainly very clear and distinct divisions of the consecutive phenomena of anæsthesia produced by chloroform. So much, however, in actual practice does each blend with and lose itself in another, that it is very rarely such stages can be made out with so much precision that they should be of much use, or serve as anything like beacons by which to steer clear of danger; and as for any certain indications of having attained the sole object we desire in administering anæsthetics at all—insensibility to pain—we can confidently depend on having done so only when patients exhibit, among other symptoms, those here constituting the fourth degree of narcotism.

It would be out of place here to enter upon the views entertained and promulgated regarding death from chloroform. It is a great deal to know that death can be produced by it, and that there is no doubt of death having been so in proportionately a small number of instances. It cannot be said that in every case the system has been *poisoned* by the chloroform, but the

patients have died; and whether their death was directly or indirectly due to it matters little, if it was due at all. The practical lesson taught is to keep a sharp look-out in every direction, to be alive to every kind of danger, and to be prepared to act at once in every emergency, as here, above all other occasions, delay or indecision is fatal. And too strong terms cannot be employed to reprobate the exhibition of such agents as chloroform or any anæsthetic by persons whose qualifications are insufficient for meeting any collateral emergency. Supposing any unfavourable symptoms to arise, what happens? Probably some medical practitioner, who has in the meantime been sent for, arrives, but only to find the patient dead; and the death is concluded to have occurred notwithstanding every endeavour having been employed. The qualified practitioner may, no doubt, have been at once called in; but it is like calling in a medical man to drag for a drowned person—medical skill is then of no avail.

The first and the principal object in exhibiting chloroform, then,—for we may here consider it as the type of all other anæsthetics,—is the avoidance of pain; but there are two subordi-

nate objects in its exhibition which are nevertheless of much importance, and most desirable; these are the avoidance of shock to the system, and the means of rendering the patient completely passive in the hands of the surgeon. None of these ends, however, will be accomplished, if the state of anæsthesia be not complete; and to produce this complete anæsthesia, and to know when it is produced, requires not only an intimate knowledge of the properties of the anæsthetic agent itself, but a certain amount of tact in its exhibition, to be acquired in no other way than by practical experience in its use.

In what cases, it may be asked, is chloroform to be refused? So far as mere foreknowledge goes, it can only be stated that no such case has been very clearly made out. In some instances, no doubt, there are physical obstacles to its inhalation,—such as the cough excited in some cases of bronchial irritation, the early accession of vomiting, even the existence of nasal polypus, and other complications connected with the act of respiration; but these are mere impediments to its administration, not contra-indications to its use, and they form, besides,

so small a proportion of cases as to be almost inappreciable. So far as age is concerned, no special contra-indications to its employment exist under this head. So far, again, as disease is concerned, it seems impossible to prognose its applicability or its non-applicability, as in the most unlikely cases its effects are often all that could be desired, while in cases where everything promises well, its employment is sometimes found to be less satisfactory, and requiring more care. In short, the propriety of its employment is to be judged of by, and consentaneously with, the effects produced; not by any prejudgment of what its results are likely to be. And so few are those instances where its use is positively precluded, that its employment may be here considered as of universal application.

The administration of anæsthetics in dental surgery is attended with some special difficulties, which lead to their employment being avoided in many cases where they might otherwise be of considerable service. In operations within the mouth, the inaccessible nature of the locality, the severe pain attending such operations, and the untoward complications apt to accompany

the anæsthetic state, contribute in making the exhibition of these agents frequently unsatisfactory. Certain extra precautions are therefore here necessary, and certain rules must be followed to secure a prospect of success. And it should be recollected that failure in this instance is much more detrimental in every way than if anæsthesia were never attempted at all.

In exhibiting chloroform for such operations as tooth extraction, everything should be so arranged that the patient may be kept under its influence for as short a time as is compatible with the requirements of the case. The sooner the anæsthesia is produced after inhalation is commenced, and the sooner the patient can be relieved from its effects when they are no longer desirable, so much the better. With this view all preparatory measures should be made before commencing with the anæsthetic. The instruments likely to be required should be selected, and laid out in order, and covered by a napkin. The chair or couch to be used should be arranged so as to suit the operator's convenience. Any mere examination of the mouth or teeth should also be made at this time, and the services of one or two competent assistants secured. The

presence of friends or relatives—unless medical —of the patient should as far as possible be discouraged. They seldom assist in any way, frequently keep the patient wakeful, and sometimes embarrass the operator.

Always bearing in mind that the part to be operated on should be placed so that the surgeon shall have the greatest possible facility for examination and manipulation, the most convenient and much the safest attitude for the patient is the recumbent or horizontal position. For this purpose a low couch or sofa raised at one end, and without a back, will be found most serviceable; the patient being laid in a semi-recumbent posture, with the head supported on the raised end of the couch, and the face turned towards the light. The dress about the throat and neck should be loose; the neck should in all cases be without any covering whatever in front, and any coverings on the chest should be so arranged that all the movements of respiration may be at once and easily observed.

In operations within the mouth it was, and to a less extent it still continues, customary to introduce a cork or some such substance between the teeth previous to and during the exhibition

of the anæsthetic; such a practice is far worse than useless. The very first inhalations of chloroform produce in many patients a slight degree of irritation in the fauces, often promote an accumulation of fluid in the mouth, and in a few minutes excite a desire to swallow. This latter act cannot be accomplished so long as anything keeps the jaws apart; the patient eventually struggles to rid himself of the difficulty, his struggles are mistaken for mere cerebral excitement, and a contest takes place between the half-insensible patient and his attendants, probably with the result that the attempt to produce anæsthesia is in the end abandoned. Instead, then, of introducing any substance of this nature between the teeth, nothing of the kind should at this stage be attempted. The patient should be left the perfectly unconstrained power of deglutition, and the chloroform should be inhaled in an easy and placid manner through the nostrils. Any forced or rapid inspirations do little good, and sometimes give rise to difficulties, as they are almost always followed by a cessation for a time of the respiratory act altogether. This symptom above everything else is to be guarded against;

and on anything like interruption to the regularity of the breathing being observed, the chloroform should be at once withdrawn.

In order that speedy insensibility may ensue, perfect silence should be maintained. The patient ought, if possible, to be without any apprehension that the anæsthetic is hazardous, or that no effect can be produced by it in his case, or that the operation will be commenced before a sufficient quantity has been inhaled. Wherever a patient is nervous or anxious about such matters, it will be found that much more time and a much larger quantity of chloroform will be required than would otherwise be the case. Another point of some importance is the frame of mind in which a patient comes under the influence of this anæsthetic. If an effort be made to go quietly to sleep, there is little chance of much struggling or involuntary restlessness. On the other hand, especially in the case of all minor operations, if a patient entertain the belief that under the influence of chloroform the conduct is necessarily outrageous, it seldom fails that such an idea is practically realised. Indeed, in not a few instances it would almost appear as if the patient had premeditated the

display sometimes made during the exhibition of such agents; and in all cases it is advisable that he should be instructed to remain as quiet as possible so long as sensibility is retained. In this way, with a little effort on the patient's part, the whole operation may be rendered much more satisfactory both to himself and the surgeon.

The means of exhibiting the anæsthetic itself has been a subject of considerable discussion; and in dental surgery this is a point of some importance. Various forms of inhalers have from time to time been brought forward, each being by its own advocate described as superior to all the others, and all of them as preferable to exhibiting such agents on a napkin or handkerchief. It must be kept in mind, however, that the less we have to attend to besides the patient the less risk is there of danger; whereas, if attention has to be bestowed on the working of an apparatus, complicated as these inhalers occasionally are, it necessarily interferes with that close watching of the patient which is in all cases absolutely essential. Much importance has been attached to the waste of chloroform resulting from the use of a napkin. A very

little consideration, however, will show this to be a waste of the most trifling description, comparatively of no moment whatever, never in any case amounting to more than the value of a sixpence, and seldom to any appreciable amount at all. Again, it has been argued that the patient gets too much chloroform by using a napkin. To this it may briefly be replied, that this is the fault of those administering it. If the chloroform be properly managed, in all probability the same quantity will require to be inhaled to produce the same effect in a given time whatever apparatus be used, unless, indeed, its exhibition be frittered away in a repetition of very small quantities, when a great deal more will be inhaled with a much less satisfactory result, and that only after subjecting the patient to an uncalled for and inexpedient protraction of every stage of anæsthesia. Another circumstance rendering any extra complication in the "inhaler" objectionable, is the frequency with which the inhalation requires to be suspended and renewed. This especially applies to operations on the mouth and in its neighbourhood, as, for instance, in the extraction of a number of teeth at a time. Here the patient often be-

comes conscious during the operation, and requires an additional dose of the anæsthetic to be administered, while perhaps the position of the head and the condition of the mouth would render any special apparatus difficult to adjust, not to speak of the flow of blood rendering it dangerous. The simplest and the safest method of administration, then, is by using a napkin or handkerchief folded once or twice, but not so often as to prevent the possibility of respiration through its thickness, and pouring upon it the chloroform in quantities of about a teaspoonful at a time, renewing it as soon as the former supply has passed off. The napkin should be held at first about three inches from the patient's face, being so handled as to prevent the chloroform vapour escaping by its own gravity, and at the same time insuring the free access of atmospheric air. As the anæsthetic effects begin to appear, such a napkin may be brought into somewhat closer proximity with the face, especially where the *capacity* for chloroform is great and the anæsthetic effects small, and kept there, unless there be any contrary indication, until anæsthesia is complete. Instead of folding the napkin, it has been proposed to use a single layer

placed over the mouth and nose, and to drop the chloroform upon this, keeping it continuously moistened with a small quantity of the anæsthetic. This method answers well in many cases where the patient is lying down, and not restless or excitable, but it is attended with some difficulties when the semi-recumbent posture is adopted; and in the case of tooth-extraction, another drawback to this mode of administration exists in the occasional tendency to move the head about, as if in apprehension that the operation was about to be commenced. For simplicity, for safety, and for convenience in the facility of its withdrawal and reapplication, over and over again, there seems no method so well adapted for operations about the mouth as the napkin folded and used as already described.

The quantity of chloroform inhaled before perfect anæsthesia is induced varies very much in different patients. There is also a great difference in the degree of rapidity with which one patient in comparison with another will inhale a given amount of chloroform. Owing to these two circumstances, the time required to produce complete insensibility ranges among various patients from a period of a few seconds' duration,

upwards, to cases where the inhalation requires to be kept up for five or ten minutes or more before a sufficient effect is obtained; and so far as general experience goes, it is among the latter class of cases that vomiting and after-sickness most frequently occur. This is of some consequence where tooth-extraction is to be the operation performed, as expedition obviously becomes essential for success when such occurrences are to be expected.

Again, something might here be said regarding the quality of the chloroform itself; but excepting that it should possess the normal strength, little difference seems to be made in this way, unless great impurities exist. For example, mythelated chloroform has now been extensively used without any evil result. Nay more, some instances have occurred where the after-sickness and vomiting seemed to be avoided by using chloroform manufactured from mythelated spirit.

It has been stated that previous to and during the exhibition of chloroform, no substance should be placed between the teeth with the view of keeping the jaws apart. After the anæsthesia is complete, however, it will in general be found

necessary to separate the jaws widely, and to retain them so in order that the operator may command a ready access to, and a full view of, the parts. And, it may be asked, how is this to be done? When the anæsthesia is sufficiently deep for performing painlessly any such operation as the extraction of a tooth, little difficulty will commonly be experienced in merely opening the mouth; since, from the muscular relaxation induced, the lower jaw will sometimes tend to drop, on simply allowing the head of the patient to fall back to a slight extent. Exceptional cases do occasionally occur where the teeth, and even the lips, are closely and forcibly kept shut. But in no instance is the difficulty so great as not to be easily overcome by merely inserting between the front teeth the end of any thin flat body, such as the handle of a tooth-brush, and rotating it so that the teeth, or where these are absent the gums, shall be separated by and rest upon its edges. This being once accomplished, any suitable gag may be introduced between the molar teeth of the side opposite that to be operated on, and by moving it further back or forwards, the same size of gag may be made to retain the mouth open to various

different degrees. In *The Edinburgh Monthly Journal of Medical Science* for April 1854, will be found an account of a speculum for purposes of this nature, and which in certain cases may be found useful, as it remains more steadily in position than those generally used, and dispenses with the necessity for being held by an assistant,—a proceeding sometimes interfering with the required amount of light and space. The instrument is tolerably well known, and for further particulars reference must be made to the above publication. On the whole, however, as with the use of inhalers, &c., the simpler all such auxiliaries are the better, and with a little judicious management, nothing in ninety-nine cases out of a hundred will be found necessary for opening the mouth and retaining it so beyond the measures already described. It need scarcely be said here, that where both upper and lower teeth are to be extracted, the operator should commence with the lower ones, as the flow of blood does not in this way tend so much to interfere with his subsequent proceedings.

Allusion has been before made to the care with which any impediment to the respiration

must be avoided in the administration of chloroform, more especially just about the period when the full effects of the agent are produced. This seems to be of much more consequence than watching the pulse, or indeed than all the other usual precautionary measures put together, as by far the most frequent and most imminent source of danger lies in the risk of suffocation. This, I am aware, is no new or singular opinion, but it is one by no means practically enforced in every case. It is, however, a point to which too much attention cannot be directed, and in such operations as those under notice, most danger is likely to occur in this manner at the very time when it is most likely to be overlooked, and that is during the operation itself. One cause of this is obvious, and has been already explained, namely, the inability to swallow while the mouth is open. If it appear, then, on looking into the mouth, that any obstacle to the entrance of air exists at the back of the cavity or in the pharynx, so that the opening of the larynx might be closed, this, it need not be said, is to be immediately and effectually removed. During the state of complete unconsciousness, and especially where

the patient is lying horizontally on the back, the tongue is apt to fall, or to be retracted somewhat towards the gullet, and in this way a danger of suffocation has been apprehended. The practice of some of our highest surgical authorities is on these occasions to draw forward the tongue with artery forceps or a tenaculum, and sometimes by means of a ligature passed through its substance. In certain cases these proceedings may be demanded, particularly in such as those where much time is likely to be occupied, and where it is desirable to keep the tongue drawn forward for a considerable period continuously. But we must recollect, that by keeping the larynx uncovered—if such be the effect of this measure—the entrance of fluid as well as air is promoted, and that an accumulation at the orifice of the larynx of a quantity of saliva or bloody fluid will choke a patient as readily as if it were closed up by the epiglottis or tongue lying there. Now, to rid himself of an obstacle to the respiration, such as saliva or blood, the patient always endeavours, even unconsciously, to swallow. But where the tongue is kept forcibly extended this is impossible, while the lodgement of fluids over and consequent

spasm of the glottis are rendered more likely to occur by its exposure. Such a mode of procedure, then, will be of little avail, unless at the same time the entrance to the larynx be sedulously kept free of fluid matters. There seems no absolute necessity, however, in the majority of dental cases for thus hooking forward the tongue at all. So long as the respiration is seen to go on, no interference of the kind is required; and when there does occur any tendency to disturbed, or obstructed, or arrested breathing, the chloroform should be withdrawn, and merely the forefinger thrust well back into the pharynx, where, by a few simple movements, the fluid can be cleared away, deglutition, in all probability, at once excited, and the tongue pulled forward if necessary. I may here be permitted to remark, that in the experience of several thousand cases of complete anæsthesia for dental operations, I have never had occasion to resort to any other measures than those last mentioned.

It is seldom before, and generally after, the accession of insensibility, that sickness with vomiting commences. And it is only when it commences before or at this stage that it forms

anything like a serious impediment to the surgical procedure, as, after this is effected, its occurrence is of but little consequence. When vomiting begins about the time of the operation being commenced, the anæsthesia is generally so well established, that on the first paroxysm of sickness passing off a very little more chloroform will restore the anæsthetic state so speedily, that before the re-accession of vomiting the operation in most instances may be successfully completed. When it begins earlier than this, however, the difficulties are increased, and in some cases render it injudicious or impossible to continue the administration of the chloroform. It is superfluous to say that, of all operations, those in the mouth and its vicinity are such as are most interfered with by vomiting. In this way it becomes a complication of a very troublesome nature to the surgeon. But it by no means rests here, for it also entails serious risk to the patient, inasmuch as in many cases there results from this cause great danger of suffocation. The vomiting, when anæsthesia is deep, often seems to be imperfect, the contents of the stomach gurgling up into the mouth, in small quantities at first, while there is an

apparent inability to eject the vomited matters any farther. In this way these are sometimes accumulated at the upper part of the gullet and pharynx, and unless due caution be exercised the larynx may thus be shut up and respiration prevented. The ordinary rule is not to exhibit chloroform until the expiry of several hours after the last meal, so that the stomach may be empty,—a condition in which it is supposed that sickness is less likely to occur. Patients, however, sometimes deceive the operator in this respect; and in other cases digestion seems to proceed at a very slow rate previous to the expected operation. In this manner, then, with a patient unconscious and utterly helpless, an operation half-completed within the mouth, and a stomach charged with half-digested food, vomiting may be conceived to be an occurrence by no means void of danger.

Vomiting in many instances does not occur until the anæsthetic condition is passing off, and it is not improbable that in certain cases the mode of rousing the patient has something to do with the accession of this after-sickness. No violent measures should be resorted to for such a purpose; no shaking of the patient; no

loud speaking or vociferating into his ears; no attempt of any kind to awake him the moment the operation is over; and, certainly, no allusion of any kind should be made to sickness or vomiting. The patient ought to be allowed to lie perfectly quiet—to have free access of air, and not be permitted to speak or be spoken to so long as any mental confusion exists. And here it becomes necessary to say a few words in favour of Ether. This agent is of great service in cases where any tendency to syncope is manifested. The addition of a small quantity of anhydrous sulphuric ether to the napkin on which chloroform is being administered will revive a patient in a way that perhaps no other agent would effect. It must be given somewhat more freely than chloroform on account of its greater volatility; but from its valuable properties in the above respect, it should always be at hand.

In concluding these remarks it may be observed, that so far as concerns the typical progressive stages of anæsthesia manifested in any individual instance, the practical experience of one or two cases would be more instructive than any amount of description. Certain progressive

degrees of insensibility have been attempted to be determinately laid down, and the distinguishing features peculiar to, and characteristic of, each of these stages to be mapped out. This has been done as a guide for the administration of such agents with the view of averting danger. But the indications of the various degrees of narcotism vary with the nervous constitution of the patient, as well as with the amount of chloroform exhibited. And so far as danger is concerned, although more assiduously to be watched for at the latter stages of narcotisation, yet it has occurred at its very commencement as well as at its completion, and even occasionally after its apparent subsidence. In this way it would seem that no ratio can be well established between any series of phenomena and either the progress of the anæsthesia or the proportionate risk accompanying each stage. An observant eye and a sound judgment, a practical acquaintance with the use of anæsthetics, and a readiness for all emergencies likely to complicate their action, are the true safeguards and the essential qualifications for the employment of such agents in dental surgery (23).

As a resumé of what has been now stated, the following points may be briefly recapitulated :—

1*st*, The difficulty attending the administration of chloroform in dental surgery arises from the nature of the locality and the severity of the pain in such operations ; together with the inconvenience and danger here incurred of untoward complications accompanying the anæsthesia.

2*d*, Everything should, therefore, be so arranged that the patient may be kept as short a time as possible under the anæsthetic. The operation ought not to be commenced before the full effect of the chloroform is produced ; and the details of the operation itself must be adapted to the passive resistance inseparable from the anæsthetic state, and to the limited time at our disposal.

3*d*, The patient should be in a recumbent posture. Nothing should be placed between the teeth while exhibiting the chloroform. The respiration above all should be closely watched, and on any symptom of its being impeded or arrested, the chloroform should be at once withdrawn, and the pharynx cleared of saliva or any other fluids.

4th, On completing the operation the patient should be allowed to awaken quietly, and without hurry or molestation of any kind.

In concluding these remarks, it may be observed, that, so far as concerns the appreciable degrees of anæsthesia manifested in any individual instance, the practical experience of one or two cases would be more instructive than any amount of description. Suppose one of the average class of patients about to be operated on, and that the inhalation of chloroform has been commenced. In general, an ill-disguised apprehension; an indefinable anxiety betraying itself in repeated and trivial interrogations and injunctions; a watchful cognisance of all going on, present themselves as familiar features of what may be termed the preliminary stage. The passing away of agitation; an interval of tranquil breathing; the accession of forgetfulness, interrupted now and then by a sudden return to consciousness; a wavering confusion, with occasionally a recurrence of the interrogative and admonitory anxiety of the first stage, characterise the earliest onset of anæsthesia. Again, the breathing becomes tranquil; occasionally, as if a hazy perception of passing events existed for a mo-

ment, the eyelids are raised, apparently in warning that insensibility is not yet complete; and now, with their reclosure, the last gleam of mental power is darkened, and all is purposeless, involuntary, unbalanced, unheeded. A few more inspirations, and the drowsy snore, the relaxed muscles, and the countenance expressive of utter unconsciousness, proclaim the full power of the anæsthetic to have been attained. Whatever pain be now inflicted, it is no longer felt. No resistance, no terrors interfere with the proceedings of the surgeon; and at their close, the dawn of returning intelligence brings no recollection of what has occurred. A dreamy sense that, for a time, oblivion has prevailed to all around; and, with the awakening intellect, the realisation that suffering has been supplanted by a sleep, usher the patient once more, as it were, into existence, and anæsthesia has fulfilled its purpose.

CHAPTER IX.

ARTIFICIAL TEETH: THEIR MECHANISM AND MANAGEMENT.

In a work such as the present, it would be out of place to give more than a mere outline of the principles involved in mechanical dentistry. A few remarks, however, on this subject may be serviceable even to those whose interest is restricted to the surgical treatment of dental diseases.

Artificial teeth are capable of being supplied for either the upper or lower jaw, and may range in number from one tooth to an entire set, above and below. They vary in their materials of construction and in the modes by which they are fixed in the mouth. Their use requires considerable practice and perseverance; and it may be stated in general terms, that the facility with which it is acquired stands in the inverse ratio to the number of teeth replaced—a single tooth occasioning very little inconvenience, while

a whole set is often irksome, and at first only managed with much difficulty. The general principle upon which artificial teeth are made is that of having a base or framework of metal or other material accurately fitting a certain area of the gum and remaining teeth, and upon which base the artificial substitutes are securely fixed. The modes in which the whole apparatus is made to retain its place within the mouth vary according to circumstances, but may be comprehended under those where a pivot or bands—the latter sometimes called clasps—attach the artificial to the remaining natural teeth; those where, without any assistance from the natural teeth, the artificial ones are maintained in position by accurately fitting the palatal surface, and known as the suction method; and those where the support is derived from what are termed spiral springs, and which can only be employed where both an upper and under set of false teeth are worn. Each and every one these varieties, however, requires experience, patience, and perseverance, to be exercised by patients in order to render themselves masters of the appliance with which they have to deal. Speaking at first presents some difficulties.

These are very speedily overcome. Eating generally presents more, and takes longer time to acquire so fully that the wearer becomes unconscious of the presence of the false teeth.

The materials of which dental substitutes are constructed generally consist in a base made of sheet gold, platinum, silver, or other metal, which, while it will not itself act injuriously, will again withstand the action of all those influences to which any substance must be subjected by constant wear within the mouth. Besides such metal plates vulcanised India rubber, or vulcanite, is employed in a similar manner. And in some few cases the old method of forming bases of hippopotamus or walrus tooth bone is still occasionally resorted to. The teeth fitted upon such bases used to be natural teeth, the sale of which, in large quantities, provided in a variety of ways, formed a lucrative trade for those who disposed of them to dentists. Now, however, what are termed mineral teeth, have entirely superseded all other material for this purpose; and such is the perfection in form, texture, and colour arrived at in their manufacture, that it becomes next thing to impossible to distinguish these structures from members of the natural series.

The base *can* be fitted to the patient's gum in almost any condition ; but the *propriety* of doing so ought always to be considered. It is inexpedient but by no means impossible to fit a plate over any number of stumps—the non-removal of which is frequently held out as an inducement to patients towards availing themselves of artificial teeth. In some cases the presence of one or two stumps in such circumstances is not objectionable, and may even be advantageous, but their liability to irritation, and the probable necessity for their subsequent removal, are matters of consequence to be taken into account, as possibly in a short time rendering an artificial set so fitted unwearable. As a general rule, therefore, where stumps exist in any number, they should be removed, and the parts allowed to absorb for at least six or eight weeks before commencing to make the artificial piece ; and, when possible, it is better still that a temporary set should be supplied to be worn for a twelvemonth, at the expiration of which time the gums will be in a much more favourable condition for the permanent set being made. The absorption of the gum and alveolar ridge, after the removal of teeth and stumps, is occa-

sionally very considerable; and in these cases, as well as in the mouths of aged patients, the employment of vulcanite, or some such more bulky substance as a base, possesses certain advantages over plate gold or other material of the kind; and sometimes a combination of the two may be employed in manner that will meet certain exigencies better than either the one or other, used singly, is calculated to do. Whatever be the material adopted in the manufacture of artificial teeth, the principle upon which they are adjusted is much the same in every case. First of all, an accurate impression of the gum and alveolar ridge is obtained by pressing upon it soft wax or other plastic substance contained in a metal *tray*—a small semicircular dish or scoop—and into which impression, on its removal from the mouth, Paris plaster is run, so as to obtain a cast or counterpart of the jaw. Should a metal base for the future set be resolved upon, a die of zinc or gun-metal, and a counter die of lead or tin, are made from the plaster cast, and between them the sheet gold, or whatever it may be, is embossed by repeated strokes of a heavy hammer. When vulcanite is the proposed material, a model of the future

set is made in wax or some such substance moulded to the plaster cast. This is then embedded again in Paris plaster, and the wax being run off by means of heat, vulcanised India rubber in the raw state is packed into the space thus left. The whole is then subjected to a certain high temperature, by which the rubber is converted into the hard substance known as vulcanite. The artificial teeth proper, are, in the plate sets, attached subsequently to the preparation of the base; but in the vulcanite sets they are fixed into the rubber at the time of its being subjected to the heating process.

What is known as a pivot tooth, again, is one secured by a metallic or other pin firmly inserted into the central canal, the pulp cavity of a tooth fang, and at its free extremity supporting the artificial crown. In this way pivot teeth can only be employed where a healthy fang remains for their attachment; and even then their applicability is limited to supplying the loss of such teeth, exclusively, as have single fangs, those most commonly thus replaced being the incisors, and, less frequently, the canines, of the upper jaw.

However accurately artificial teeth may fit

the gum upon which they rest, there are certain circumstances occasionally leading to discomfort and requiring attention before much use can be made of them. First, the adaptation of the teeth to those of the opposing jaw must be perfect before the mouth can be closed with facility; where several of the natural teeth still exist these must regulate the length of the artificial ones, and where none remain, the length must be so regulated as neither to keep the closed jaws more or less apart than their normal distance from each other. If greater than this, the unusual pressure causes irritation; if less, the effort at closure induces a feeling of weariness. Another source of annoyance, especially in masticating, occurs from the molar teeth in an upper set being placed so as to lie not on, but outside, the alveolar ridge. In this way, on closing the jaws in mastication, the effort to chew with one side brings down that opposite, in the same manner that pressing down one edge of an ordinary dinner plate tilts up the other. To obviate this, the summit of the alveolar ridge should, if at all possible, be made to correspond with the central line of the artificial molar series on each side.

The edges of the base into which the gums or palate is received, may occasion irritation from being too deep. This occurs chiefly in lower sets, and in them is very generally met with either immediately behind the incisors, or towards the back of the jaw and between the cheek and alveolar margin. The latter situation is the most common seat of such uneasiness in the upper jaw also. Sometimes the spiral springs, from their being too long, or from their position causing pressure on the gum or cheek, occasion considerable discomfort, and not unfrequently the mere presence of the artificial apparatus as a whole is sufficient to make an irritable patient extremely miserable. In all these cases a little adaptation of the set, or sets, according to circumstances, will, with patience and perseverance on the wearer's part, generally conduce to comfort being attained in a few days' time, and to such a degree, that it becomes unpleasant for the patient to be without them.

It occasionally happens that the bands or clasps surrounding any remaining natural teeth lead to extreme tenderness of that part covered by them. This occurs without the surface of the tooth necessarily presenting any appearance

of lesion, and may be removed by the application for a few seconds of a strong solution of chloride of zinc to the spot affected. Sometimes a certain part of the gum becomes swollen, inflamed, and exceedingly irritable from one of these bands being bent or its edge pushed too far down upon the neck of the tooth. And not unfrequently, where a plate is continuously retained within the mouth, the whole surface of the gum over which it is applied is found to be red, tumified, and tender. In both cases the nature of the cause points out the remedy. Such are some of the circumstances explaining the more common discomforts attaching to artificial teeth, and a knowledge of which may be useful in suggesting what is required in cases of the kind, coming, as they occasionally do, under the notice of the general practitioners. As a general rule, the regular removal and cleansing of artificial teeth prevents much uneasiness which would otherwise result from their wear. And in cases where such removal is difficult, and even inexpedient, as sometimes unavoidably happens, the mouth should be kept as free from impurity as possible by the frequent and regular use of some of the

ordinary antiseptic preparations of the pharmacopœia.

It seems almost superfluous to state that the remarks now made on these subjects are not intended for anything like instructions in the art of mechanical dentistry. This is a branch with which very little acquaintance can be made apart from the practical experience not only of the operating room but of the workshop. It was thought, however, that the present volume might be more complete by a chapter being added conveying some information regarding the nature and use of artificial teeth. With this view, some of the more salient points in the question have been briefly and in a very sketchy manner touched upon. Much service has been rendered by artificial teeth ; indeed, it is not too much to say, that in all probability many lives have been prolonged by their use ; a proposition as fairly presumable from facts as it is consistent with the inference of the essential importance of a masticating system of some kind, deducible from the all but universal presence of dental organs or their analogues throughout the higher orders of the animal kingdom.

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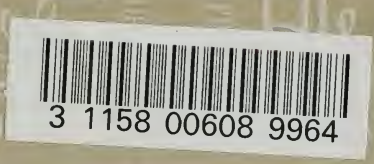
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